Consumer adoption of household energy efficiency measures, Report DIG-09

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Consumer Adoption and Use of Household Energy Efficiency Products

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People-centred ecodesign project:
Energy efficiency study

Consumer adoption and use of household energy efficiency products

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with Stephen Potter and Horace Herring

Final Report

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Diagram of condensing boiler from T206 course courtesy of The Open University.

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Abbreviations

Abbreviation	Definition
LZC	Low and zero carbon (technologies)
LI	Loft insulation
HC/P	Heating control timer/programmer
TRV	Thermostatic radiator valves
CB	Condensing boiler
CFL	Compact fluorescent lamp
LED	Light emitting diode (LED) (lighting)
STWH	Solar thermal water heating
PV	(Solar) Photovoltaic
Micro-CHP	Micro combined heat and power
MWT	Micro wind turbine
WBS	Wood burning stove

EXECUTIVE SUMMARY

Why another report on UK household energy efficiency?

Improving the energy efficiency of homes, which in 2005 were responsible for 28% of total UK carbon dioxide emissions, is a key element of the UK Government's energy and climate strategy. However, despite the Energy Efficiency Commitment (EEC), which requires UK electricity and gas suppliers to meet targets for promoting household energy efficiency, and the efforts of the Britain's network of Energy Efficiency Advice Centres (EEACs), household adoption of established energy efficiency measures, such as loft and cavity wall insulation, condensing boilers and energy efficient lighting, has been slow. For example, over 15 million homes could benefit from new or top-up loft insulation and 17 million homes do not yet have an A-rated condensing boiler. Together these measures would save about 10% of domestic carbon emissions (DTI, 2005).

According to the Government's Energy Efficiency Action Plan, this slow adoption is due to three main barriers – up-front costs; lack of information; and hassle and disruption (DEFRA, 2004). However, other research (e.g. Guy and Shove, 2000) has shown that peoples' motivations and actions concerning energy efficiency are often more complex than these barriers suggest. For example, the reasons for adopting or rejecting a product whose function is improving energy efficiency, such as loft insulation, may differ from products also involving user interaction, such as heating controls, or products that form part of a home's interior design, such as lighting (Stokes et al 2006). Also, even if householders adopt energy efficiency measures, they may not use them in an energy-saving manner. For example, many people fail to understand, or could not be bothered with, central heating controls such as central heating programmers or thermostatic radiator valves and thus do not use them properly. There may also be rebound effects, such as taking the benefits of insulation in higher room temperatures; leaving an efficient heating system on for longer, or installing extra energy efficient lighting in the home or garden. Such rebound or 'comfort taking' effects are recognised in estimating the energy saved by home insulation, but are not generally understood or taken into account for other energy efficiency measures (DEFRA, 2007).

> **This report gives the results of a study carried out by the Design Innovation Group at the Open University (OU), in collaboration with Milton Keynes Energy Agency (MKEA), that aimed to investigate in detail the drivers and barriers underlying UK householders' decisions to install – or reject –four important energy efficiency measures and users' experiences of the measures once installed, including their views on rebound effects. We also gathered respondents' ideas for improving the energy efficiency measures concerned.**

As the National Consumer Council (2006) said in response to the Government's 2006 Energy Review, 'a better understanding is needed of the key motivations and influences of different groups of consumers.... In this way, energy efficiency messages can be targeted and made more effective'.

What this report is about

This report presents results of project which surveyed UK householders' reasons for installing – or considering but rejecting – four significant domestic energy efficiency measures:

- loft insulation – new or top-up to 270mm thickness as required under 2005 Building Regulations;
- condensing boilers – before and after they became virtually mandatory under 2005 Building Regulations;
- heating controls – focusing on central heating programmers and thermostatic radiator valves (TRVs);
- energy-efficient lighting – compact fluorescent lamps and the more recently introduced light emitting diode (LED) lamps.

The surveys also identified the benefits and problems experienced by those householders who had installed one or more of these measures, including their views on rebound effects. In addition the surveys asked householders to respond to ideas suggested by energy experts for improving the installation, design or technology of these energy efficiency measures and to suggest their own improvement ideas.

Cavity wall insulation was not included in this survey because, although it is one of the most important measures for improving domestic energy efficiency, once installed it lacks any interaction with the householder and hence was unlikely to yield user ideas for improvements, which was one of the objectives of this study.

The sources of data

The data on the drivers and barriers to adoption of the selected energy efficiency measures, and adopter experiences of their use, was gathered during 2006 via an online questionnaire linked to the websites of the Energy Saving Trust (EST) and a BBC/OU television series on climate change. The nearly 400 responses to this online survey data was supplemented with the results of over eighty in-depth telephone interviews with the clients of two Energy Efficiency Advice Centres (EEACs) managed by MKEA who were seeking advice about insulation or efficient boilers. The online questionnaire and interview schedules were developed following exploratory interviews with volunteer consumers and an online survey of energy efficiency professionals such as housing officers, architects and energy consultants.

The survey respondents

The respondents to the online questionnaire accessed via the EST and BBC/OU websites were self-selected and not unexpectedly were ‘greener’ and from higher socio-economic groups than the general UK population. More unexpectedly, the EEAC clients we interviewed expressed similar levels of general environmental concern and were also largely middle class by occupation. However, the EEAC group’s reasons for adopting energy efficiency measures were more financially and less environmentally driven than the online respondents and included a higher proportion of retired people.

This is therefore a ‘purposive’ rather than a representative survey. Our respondents’ reasons for rejecting energy efficiency measures, and any problems experienced by those who did adopt them, thus represent significant barriers and issues that need to be addressed before the less wealthy, less ‘green’ general UK population will decide to install one or more of these energy efficiency measures and thus achieve the worthwhile carbon reduction benefits that their widespread adoption is estimated to bring.

The People-centred ecodesign project

The surveys of household adoption of energy efficiency measures presented in this report form part of a larger project entitled ‘People-centred ecodesign’ (Roy, Caird and Potter, 2007; Herring, Caird and Roy, 2007). As well as investigating energy efficiency measures, this project also examined the drivers and barriers to UK household adoption and effective use of four domestic renewable energy technologies:

- solar thermal water heating
- solar photovoltaics (PV)
- micro-wind turbines
- wood-burning stoves.

The energy efficiency survey results are based on the responses to the same online questionnaire that was used for the renewable energy study reported separately (Caird and Roy et al, 2007; Herring, Roy and Caird, 2007).

In the following sections key findings of the energy efficiency study are provided in summary tables and as a more extended text discussion.

Key findings – summary tables

Table A summarises the main drivers for, and barriers to, household adoption of the four energy efficiency measures covered in the surveys, together with the main benefits and problems experienced by the householders who adopted one or more of these measures.

Table A. Main drivers for, and barriers to, household adoption of energy efficiency measures and main benefits and problems experienced during their use

	Loft insulation (new or top-up to 270 mm or more)	Central heating controls (progrmer, TRV)	Condensing boilers	Energy-efficient lighting (CFLs; LEDs)
Drivers for adoption (percentage adopters – online survey)	**Saving energy** (84%; Also 43% interviewees) **Saving money** (81%) **Rising fuel prices** (71% interviewees) **Wanting a warmer home** (77%; Also 71% interviewees) ***Environmental concern*** (68%; Also 21% interviewees) Affordable after subsidy (32%; Also 21% interviewees)	**Saving energy** (78% progmrs 59% TRVs) **Saving money** (74% progmrs 57% TRVs) ***Environmental concern*** (57% progmrs; 45% TRVs) Low cost special offer (10% progmrs 7% TRVs)	**Saving energy** (77%) **Saving money** (69%) **Existing boiler needs replacing** (60%; Also 86% interviewees) ***Environmental concern*** (60%) *Wanting a warmer home* (35%) Received grant /special offer (10%)	**Saving energy** (91% CFL 57% LED) **Saving money** (82% CFL 34% LED) ***Environmental concern*** (60% CFLs; 11% LEDs) Was free or low cost special offer (27% CFLs)
Barriers to adoption (percentage *non-adopters* – online survey)	*Loss of loft storage space* (37%) *Trouble clearing loft before installation* (33% esp. elderly)	*Hassle involved in installing* (47% TRVs; 17% progmrs) Likely fuel savings not worth cost (26% progmrs; 20% TRVs)	**High cost of replacing a still functioning conventional boiler** (70%) *Reputation of condensing boilers for unreliability/ shorter life* (43%) *Problems connecting to existing heating/plumbing* (34%)	*Large size and perceived ugliness* (42% CFLs) *Still too expensive* (33% CFLs 40% LEDs;) *Incompatibility with existing light fittings and/or dimmers* (33% CFLs 39% LEDs;) *Unpleasant light quality/colour* (33% CFLs) *Not widely available* (40% LEDs)
Benefits experienced in use (percentage adopters – online survey)	**No problems** (71% interviewed adopters) **Warmer home** (58%; Also 82% interviewees) *Greater concern about saving energy* (41%; Also 46% interviewees) Lower fuel bills (29%; Also 36% interviewees)	***Easy to use*** (71% progmrs 58% TRVs *Greater concern about saving energy* (40%) *Lower fuel bills* (33%) Warmer home (32%)	**Met expectations well/very well** (68%) *Greater concern about saving energy* (40%) *Lower fuel bills* (40%) *Warmer home* (36%)	**Met expectations well/very well** (81% CFLs; 51% LEDs) *Greater concern about saving energy* (37%) Reduced fuel consumption (23%)

Bold = 66% or more responses ***Bold Italic*** = 50% or more responses
Italic = 33% or more responses Normal = Other responses (less than 33%)

	Loft insulation (new or top-up to 270 mm or more)	Central heating controls (programmers, TRVs)	Condensing boilers	Energy-efficient lighting (CFLs; LEDs)
Problems experienced in use (percentage adopters – online survey)	Loss of loft storage space (10%)	Don't use programmer (29% interviewed adopters) Control buttons/displays too small (11% esp. elderly) Controls difficult to understand (9% esp. elderly) Don't how to use controls to save most energy (9%)		*Too large/ugly* (41% CFLs) *Incompatibility with dimmers* (35% CFLs) *Slow warm-up* (34% CFLs)
Rebound effects (percentage adopters – online survey)	Rooms heated to higher temperature (3%; Also 29% interviewed adopters)			Lights left on longer (11% CFLs/ LEDs) Additional lighting (6% CFLs; 10% LEDs)

Table B lists technical, organisational and communication ideas and policies that survey respondents considered would encourage householders to adopt energy efficiency measures and/or address the problems experienced in use.

Table B. Ideas and policies to encourage household adoption and effective use of established energy efficiency measures

	Loft insulation	Central heating controls (programmers/ TRVs)	Condensing boilers	Energy efficient lighting (CFLs; LEDs)
Design improvements/ technical innovations (percentage adopters – online survey)	**More non-irritant and eco-friendly insulation materials** *(76%)* ***Thinner, less bulky insulation materials*** *(60%)* *DIY or professional systems to provide storage above insulation (39%)*	***Controls designed for all users (incl. elderly & disabled)*** *(56%)* ***Controls that give users feedback on energy costs & consumption*** *(53%)* ***Intelligent controls that automatically optimise comfort & energy use*** *(51%)* *Controls in prominent location in home* (41%)	***Boiler that displays its working efficiency*** *(52%)* *Easier to service condensing boilers* (34%) *More reliable and durable condensing boilers (32%)*	**CFLs similar to incandescent lamps and fittings** esp. halogen spotlights and miniature lamps (72%) ***Dimmable CFLs*** (55%) ***LEDs suitable for general lighting*** *(57%)* *Improved light quality e.g. less harsh light* (CFLs 42%; LEDs 46%)
Organisational/ marketing changes (percentage adopters – online survey)	Subsidised insulation schemes to include non-irritant and eco-friendly materials	*Instructions or program for users to optimise comfort and energy use considering their dwelling, heating system and needs* (41%)	Better training for installers of condensing boilers	*Wider availability of efficient lamps in shops* (44%) Publicity about improvements in CFL design and technology

The information in Tables A and B (adapted from Roy and Caird, 2007) is classified according to the frequency of responses in the relevant sub-sample, mainly from the EST/BBC/OU online survey, as follows:

Bold = 66% or more responses
Bold Italic = 50% or more responses
Italic = 33% or more responses
Normal = Other responses (less than 33%)

Key findings – in more detail

Drivers for installing household energy efficiency measures

Householders who install energy efficiency measures do so for many reasons; but the key drivers most frequently cited by this group of mainly ‘green’ consumers were saving energy and/or reducing fuel bills and/or concern for the environment. For loft insulation these drivers were matched by a desire for warmth and for condensing boilers by the need to replace an existing boiler.

The above key drivers were most frequently cited by the adopters of loft insulation, central heating programmers, condensing boilers and CFLs. For these measures, saving energy and/or reducing fuel bills was cited by over 70% of respondents to the online survey, while concern for the environment was cited by 60% or more. This is in line with general UK household surveys on drivers for adopting energy efficiency measures (e.g. npower, 2007). For loft insulation these key drivers were matched by the desire for a warmer home (cited by over 70% of all respondents), and for condensing boilers by the need to replace an existing conventional boiler (cited by 60% of online and nearly 90% of interviewed respondents). Adoption of TRVs and LED lighting were driven more by the wish to save energy and/or fuel bills than the other reasons.

The importance of environmental concern (especially climate change and nature conservation) as a key driver was probably due to the ‘greenness’ of the majority of our respondents.

The interviewed respondents were somewhat less green – for example, over 70% citing saving money, rising fuel prices and/or a desire for increased warmth, and only about 20% giving environmental concern, as their main drivers for installing loft insulation.

The role of subsidies, grants and special offers

Available subsidies, grants and special offers played a surprising small role in encouraging this group of householders to install energy efficiency measures. It seems that most wanted to improve the energy efficiency of their home before considering whether grants, subsidies or special offers helped to make adopting a particular measure affordable.

Less than a third (32%) of online respondents and only a fifth (21%) of interviewed EEAC clients (who would have been told about the lowest-cost insulation offer available from an energy supplier) cited subsidies or special offers as a key reason for installing loft insulation. About a quarter (27%) of online respondents said a key reason for getting one or more CFLs was because they were free or subsidised. Only a few online respondents installed new central heating controls (10% programmers, 7% TRVs) because of special offers available via some installers. Similarly only 10% of online respondents said grants or special offers were key reasons, either for choosing a condensing boiler in preference to a conventional boiler before they became virtually mandatory in April 2005, or for early replacement of a working conventional boiler after that date. However, this result is partly due to the fact that special offers on controls and subsidised condensing boilers are not widely available.

Barriers to installing, benefits and problems in use, and improvements to energy efficiency measures

While the drivers for installing energy efficiency were broadly similar for the different measures, the barriers to their adoption, the benefits enjoyed and any problems experienced by the householders who adopted them, as well as users’ ideas for improvement, varied for the different measures. Therefore, in the rest of this summary the findings concerning barriers, benefits, problems and improvements are considered separately for each measure. The most significant findings are highlighted in boxes.

Loft Insulation

Over 90% of UK homes have some loft insulation but bringing the 15m suitable UK homes to the recommended 270mm of insulation is estimated to save 1.28m tonnes carbon per year, that is about 3% domestic emissions (Shorrock and Utley, 2003, DTI, 2005). More recent figures give 6.2 million homes suitable for new or top-up loft insulation and 1.2m tonnes carbon saving per year, excluding comfort taking which is estimated to reduce the savings by 15% (DCLG 2006).

Householders who decided against installing loft insulation did so mainly because it would reduce loft storage space and/or because of the trouble of clearing the loft. Overcoming these barriers should help increase installation rates.

New or top-up loft insulation to the recommended 270mm thickness is available to UK households under subsidised or free installation EEC schemes. Only 15% of online respondents who seriously considered loft insulation rejected it. The most frequently cited deterrents to installation were loss of storage space (37% of non-adopters in the online survey) and/or trouble clearing the loft (33% of non-adopters). An even higher proportion of the energy efficiency professionals we surveyed (76%) also recognised loss of storage space as a significant barrier to installing loft insulation.

> *'Floor boards would not fit over 10" (270mm), we had difficulty in fitting six inches of insulation and being a small cottage we need the storage space.' (Loft insulation non-adopter)*

> *'Loft insulation is difficult to work with and can be irritable upon contact with the skin. I really did hesitate before using loft insulation, because I wanted to be able to access the loft on a routine basis'. (Loft insulation adopter)*

In open comments a few adopters and non-adopters mentioned they were deterred by the health effects of the glass or lava fibre normally used for loft insulation, some mentioning their preference for eco-friendly materials such as recycled paper, which are not available in EEC subsidised schemes.

The critical time for installing loft insulation is before a householder plans to board the loft and delays by insulation installers may lead people to go ahead with other loft improvements. Energy Performance Certificates could encourage house-buyers to install 270mm insulation before embarking on other loft improvements.

An important insight gained from interviews with non-adopters is that there is a critical timing for installing loft insulation. Thus any delay by the installer or homeowner to install loft insulation may lead to boarding with the result that the insulation may never be laid. Energy Performance Certificates introduced from 2007 could help encourage home-buyers to think about insulation before making other home improvements.

The main benefit of loft insulation is a warmer home, indicating a significant rebound effect associated with this energy efficiency measure, although some adopters also noticed reduced fuel bills.

About 60% of online and 80% of interviewed adopters said the main benefit of loft insulation was a warmer house, while about a third said they also had lower fuel bills. These results typify the well-known 'rebound effect' of home insulation, where adopters take some or all the benefit in higher room temperatures (nearly 30% interviewees), heating more of the house or for longer periods. The official 'comfort factor' for loft insulation of 15% (DEFRA, 2007) may be an underestimate (Sorrell, 2007). Five respondents mentioned that loft insulation also helped keep their home cooler in summer; likely to become increasingly important with climate change, but not generally mentioned in insulation programmes.

'We reduced the temperature of the upstairs radiators and turned down the central heating thermostat by 2 degrees to 19 degrees C.' (Loft insulation adopter)

'Makes the house much cooler in the summer' (Loft insulation adopter)

10% of the online adopters complained about the loss of storage space in their loft and this has led some to remove insulation or compress it under boarding. These actions would reduce the energy savings provided by the insulation.

Over 40% of respondents said installing loft insulation increased their concern about saving energy. Hence loft insulation may prime people to install or consider purchasing other energy efficiency measures.

Over 40% of adopters (both online respondents and interviewees) said that they were more concerned about saving energy since installing loft insulation. Many loft insulation adopters owned at least one other energy efficiency measure, especially heating controls and/or CFLs.

More people would install 270mm or more mineral fibre loft insulation given a better post-insulation storage system. Others might be encouraged if higher performance, less bulky or eco-friendly insulation materials were available in subsidised insulation schemes.

Post-insulation loft storage clearly needs a better solution than those currently available; a professional task of raising the joists and boarding or individual 'bodged' solutions. Nearly a third (31%) of non-adopters would have installed loft insulation given a better post-insulation storage system. Insulation also offers challenges for materials innovation. Over half of the non-adopters said that non-irritant, eco-friendly (57%) and/or higher performance, less bulky insulation materials (54%) would have encouraged them to install. Such insulation materials are not available in EEC subsidised schemes.

Central Heating controls

Over 90% of UK homes have central heating, mainly from a gas-fired boiler and radiators equipped with one or more heating controls; thermostat(s), a timer/programmer and/or thermostatic radiator valves (TRVs). Effective use of existing controls is estimated to save about 3% UK annual heating energy consumption (MTP, 2004), while installing improved controls could save about 1% of the total (DTI, 2005). A recent estimate is that improved heating controls in 2 million homes could save 0.2m tonnes carbon per year (DCLG, 2006).

Most householders decide against purchasing new or improved heating controls mainly because of the effort of getting them installed and because the fuel savings are considered not to be worth the cost and hassle involved. Many householders retain existing controls even when upgrading their heating system.

The reasons that householders who considered installing new heating controls – central heating programmers and/or thermostatic radiator valves (TRVs) – but decided not to do so were because they were regarded as too much trouble to install (47% TRVs and 17% programmers) and/or because householders considered that the fuel savings were not worth the cost (20% TRV and 26% programmers). Our surveys indicate that people often keep existing controls when upgrading their heating system, due to a combination of hassle and the perceived poor cost-effectiveness of installing new controls.

Most adopters of central heating programmers and TRVs find them fairly easy or easy to use. A few users, especially the elderly, report that programmers are difficult to set or are over-complex.

Most adopters of programmers (71%) and TRVs (58%) find them fairly easy or easy to use. But a few users (11%), especially the elderly, find electronic programmers with tiny buttons and LCD displays difficult to see and understand

> *'They are more complicated to set up than the system we had in our old house and also are more restrictive and make it more difficult to save energy. Too many options mean it is easier just to leave the damn thing on'. (Heating control user)*

A few adopters mentioned difficulties using TRVs with their small markings, unrelated to room temperature, that need to be set on each radiator by trial and error. Such problems may mean that programmers and TRVs may never be adjusted or used; and 29% of interviewees turned their heating on and off using the room thermostat. . This is an issue well recognised by the energy efficiency professionals we surveyed, two-thirds (68%) of whom felt that heating controls were difficult to understand and operate, especially for the elderly.

A third of new or improved heating control users report reduced fuel bills. But a quarter to a third of users are also enjoying more heat and/or a warmer house, a rebound effect not normally associated with this energy efficiency measure.

A third of the online adopters of programmers and TRVs noticed reduced fuel bills, but a third also noted a warmer house and up to 13% of users admitted they took the main benefit of new controls in additional heating or hot water, suggesting some rebound effects not allowed for in official estimates of energy saving from extra heating controls (DEFRA, 2007).

Many householders are unclear about the best way to operate their controls to minimise energy consumption and maintain comfort. There is a need for better consumer information from installers, manufacturers and energy advisers on the most effective way to use central heating controls.

Some users believe that it is more efficient to switch water and space heating on and off either manually or using a programmer, whereas others (about 30% of interviewed users) leave their heating on constantly and use their thermostat and/or TRVs to achieve desired comfort levels.

> *'It's very difficult to get any idea as to the key things which impact on energy usage. Is it better to have the heating on constant and low or timed but higher temperatures? ... Very easy for everything to become "too difficult" and hence we do nothing.' (Heating control user)*

There is a need for better instructions, or perhaps a computer program, to enable users to control their heating to optimise comfort and energy use taking into account the characteristics of their dwelling, heating system and needs.

The majority of adopters of heating controls would like 'inclusively' designed, intelligent heating controls that optimise comfort and energy use and provide feedback and operate automatically, but with a manual over-ride option.

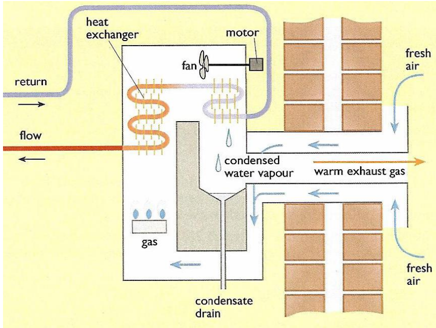
For heating controls, over half of adopters agreed with or mentioned one or more of the following as good ideas: controls that automatically optimise comfort and energy use; provide feedback on energy consumption, are designed for all users (including the elderly and disabled); display room-based heating times and temperatures; and detect where heating is required. A quarter to a half of non-adopters said these improvements would encourage them to install new controls. Other ideas suggested by users include controls that can be adjusted remotely via a portable device or the internet.

Condensing boilers

Under 2005 UK Building Regulations new or replacement boilers must be energy-efficient condensing designs, which if installed in 17 million suitable homes would save about 7% of household carbon emissions, making condensing boilers one of the most effective energy efficiency measures (DTI, 2005). A recent estimate is that condensing boilers installed in 17 million homes would save 3.0m tonnes carbon per year (DCLG, 2006).

Nearly half of respondents to the online survey who seriously considered installing a condensing boiler decided against purchase. Householders decided against adoption of a condensing boiler before they became virtually mandatory

in 2005 or against early replacement after 2005, mainly because of their cost and because they have had a reputation for unreliability and shorter product life.



Since April 2005 condensing boilers are virtually mandatory under UK Building Regulations; hence non-adopter responses reflect their experiences before this date, or post 2005 decisions against early replacement of a conventional boiler.

The majority of non-adopters (70%) considered them too expensive compared to the then conventional (non-condensing) boilers or as an early replacement option. The reputation of condensing boilers for unreliability and having a shorter life was the second most frequently cited deterrent for 43% of non-adopters.

> *'The supplier said that for a condensing boiler to be as efficient as advertised it would need to be used "flat out" and we would probably not be pushing the system that hard, and that if it were used in that reduced way, it would produce acids that would rot the boiler sooner'. (Condensing boiler non-adopter)*

> *Reluctantly we had to accept that no other type is now available. I do not expect it to last even half the time of the old boiler and therefore it offers no overall improvement long term. (Condensing boiler adopter)*

Two-fifths of condensing boiler users noticed reduced fuel bills while a third say they also have a warmer house. Only about 5% of condensing boiler adopters said they heat their home more after installation.

This suggests that condensing boilers have relative few rebound effects and are worth promoting as vigorously as possible.

Many (40%) adopters of condensing boilers noticed reductions in fuel bills. However, a third (36%) also noted a warmer house although only 4-5% of users admit to heating more of the house for longer periods or to higher temperatures. This indicates relatively minor rebound effects associated with this energy efficiency technology.

Nearly half of non-adopters would be encouraged to install a condensing boiler if they had more confidence in their reliability and durability. The majority of adopters of condensing boilers would like display of boiler working efficiency.

Nearly half (46%) of non-adopters of condensing boilers would like more durable designs, while only about third of adopters (32%) were concerned about this, reflecting significant improvements in the reliability of condensing boilers since their introduction. About half of adopters (52%) would like to see the condensing boiler's working efficiency displayed.

Compact fluorescent lamps

Widespread adoption of compact fluorescent lamps (CFLs) could immediately save 0.6m tonnes carbon per year, about 1.5% of the UK household total (DTI, 2005).

Most online survey respondents owned at least one CFL. The main barriers to installing additional CFLs were consumer perceptions about the large size, unattractive appearance and light quality of CFLs compared to incandescent lamps and halogen spot-lamps. Incompatibility with dimmers and slow warm-up were other barriers. Clearly many users do not realise that CFLs have improved considerably since their introduction. Manufacturers, retailers and energy advisors could do more to promote and supply the latest CFL designs.

Over 70% of householders in the online survey owned one or more CFLs. However, their experiences and perceptions stopped many of them from installing additional CFLs, with complaints about size and appearance (41%), incompatibility with dimmers (35%), slow warm-up (34%), and incompatibility with existing lampshades and light fittings (29%). Many of the energy efficiency professionals surveyed also cited these barriers to household adoption.

'CFLs are too ugly for the living room. You do not really want them to last as long as they do'. (CFL user)

However, these responses indicate that many consumers do not realise that CFL design and technology has improved considerably since their introduction. Although a variety of types and sizes of CFL are now produced, the non-standard designs e.g. spot-lamps, miniature lamps, dimmable lamps, etc. are only available from specialist suppliers and are not widely advertised or stocked by large UK retailers. It is not surprising therefore that most consumers, and many energy professionals, are unaware of their existence.

A minority of householders surveyed completely rejected CFLs. The main barriers were their perceived size and appearance, their cost, incompatibility with existing light fittings or dimmers and their harsher light quality, again indicating that these consumers do not realise that CFL prices have fallen considerably and that their design and technology has improved since their introduction.

Only 6% of online respondents had considered CFLs but decided not to get any. The biggest deterrent was their perceived size and ugliness (42%), followed by their cost, incompatibility with existing shades and fittings, and/or their light quality compared to filament and halogen lamps (all 33%), inadequate brightness and/or incompatibility with dimmers (both 29%).

Light levels are low and I don't really like the cold white colour - I've abandoned in three rooms and gone for halogen spots. (CFL rejector)

Most users are satisfied with their CFLs and like their long life, but some are disappointed when the lamps fail earlier than advertised, which may deter further purchases. Manufacturers and retailers need to be more accurate with claims about the long life of CFLs.

A majority (81%) of CFL users said that the lamps met their expectations fairly or very well. They liked CFLs' long life, but some (15%) expressed annoyance if a lamp failed after one to three years rather than the advertised life of eight to ten years. The life of CFLs thus acted as a driver, but also a barrier to further purchases if the lamp failed early.

Nearly a third of CFL users noticed reduced energy consumption. However, a few are leaving CFLs on longer than incandescent lamps, indicating a relatively minor rebound effect.

'I have electric and gas usage records for the past 28 years. I can see a noticeable reduction in electricity usage when we installed energy saving bulbs in all of our lights' (CFL user)

'I now leave a light on in the hallway all day so that I don't have to come home to a dark house. I am also happy to leave the landing light on all night for my son. I would still prefer not to have the lights on all day, but feel better that the lights are energy efficient.' (CFL user)

A third of CFL users mentioned reduced energy consumption (32%) and about a quarter reduced electricity bills. However, a few (11%) users chose to leave CFLs switched on longer than incandescent lamps and/or installed additional CFL lighting in their home or garden, or for security (6%). This supports empirical research on comfort taking for CFLs (NES, 2004).

The improvements users most often wanted were even more efficient CFLs, compatible with existing fittings and dimmer switches.

The improvements adopters most often wanted were even more efficient CFLs (64%), compatible with dimmer switches (55%) and existing light fittings, such as halogen spotlights and candle lamps (72%). Users would like also to see a wider availability of CFLs in the shops (44%), different colour rendering such as a less harsh light quality (42%).

> *'I was very surprised at how pleasant the light is – my preconceptions based on the unpleasantly cold light of the early models had prejudiced me against them before.' (CFL user)*

Most of these improvements already exist, so it is important to inform consumers, energy advisors and retailers about the new designs.

Light emitting diode (LED) lighting

> **Only a few online survey respondents had adopted LED lighting. The main barriers to adoption are the cost and poor availability of LEDs and incompatibility with existing light fittings. Many householders would like more information about using LEDs for lighting.**

Only 7% of online respondents had installed LED lighting, while 16% had considered LEDs but decided not to adopt. LEDs are a relatively new technology and some 40% of non-adopters mentioned their lack of availability and high cost. About a third of non-adopters of LEDs also said they were deterred by their incompatibility with existing fittings (39%) and inadequate brightness (29%). Clearly they were unaware of LED lamps compatible with halogen spot-lamp fittings. Indeed many householders do not know what LED lighting is and about half of non-adopters would like more information about LED lighting for the home.

> **Only half of users are satisfied with their LEDs, the main complaints being inadequate brightness, unpleasant light quality and the suitability of LEDs only for decorative lighting.**

Only half of LED users were satisfied with their purchase. The main problems experienced by LED users were insufficient brightness (20%) and a light quality which makes LEDs mainly suited only for decorative lighting (9%).

> *'LEDs provide excellent background and decorative lighting for a modern living room and are ideal for watching TV, you can just about read with the LEDs.' (LED adopter)*

Micro combined heat and power

Although not reported in the key findings summary tables, the online survey included a question about the drivers and barriers to adoption, and user experiences of, micro-CHP systems. Domestic-scale micro-CHP systems, which produce both heat and electricity, is an emerging technology that was undergoing UK trials in 2006 to assess its performance and carbon saving potential when the online survey was conducted.

> **Only three online survey respondents had installed a micro-CHP system. However, 15% of online respondents claimed they had considered installing micro-CHP but decided against doing so, mainly because of the cost, the uncertainties associated with a new technology and anticipated problems connecting to existing heating and electricity systems.**

The majority of non-adopters of micro-CHP would like better information about this technology for domestic use and a better price for any surplus electricity exported to National Grid.

1 Introduction

In order to address the problem of climate change the UK Government set a legally binding target of reducing the nation's carbon emissions from their 1990 levels by 26% to 32% by 2020 and by 60% by 2050 (HM Government, 2007) and is expected to exceed its commitment under the Kyoto Protocol to reduce greenhouse gas emissions by 12.5% between 2008 and 2012 (DTI, 2006). The development and rapid adoption of 'low and zero carbon' (LZC) products and systems to reduce the 28% of all UK carbon dioxide emissions that arise from direct energy consumption by households is a key element of the Government's energy and climate strategies (HM Treasury, 2005).

Many low and zero carbon (LZC) products and systems are now available for domestic installation, ranging from established energy efficiency measures such as loft insulation, central heating controls, condensing boilers and compact fluorescent lamps (CFLs) to more innovative micro combined heat and power (CHP) units, light emitting diode (LED) lights and household renewable energy technologies, such as solar thermal water heating and photovoltaic systems. However, consumer adoption of LZC products and systems has been relatively slow, particularly of the more innovative energy efficiency measures and renewable energy technologies.

This report considers consumer adoption and rejection, use and improvement of selected domestic energy efficiency measures, while a separate report (Caird et al., 2007) and papers (e.g. Herring, Roy and Caird, 2007) is concerned with household renewable energy technologies.

Widespread adoption of energy efficiency measures can yield significant carbon reductions. For example, loft insulation is one of the most cost-effective energy efficiency measures. Over 90% of UK homes have some loft insulation but bringing the 15m suitable UK homes to the recommended 270mm thickness of insulation is estimated to save 1.28m tonnes carbon per year, about 3% of annual domestic emissions (Shorrock and Utley, 2003; DTI, 2005). More recent figures give 6.2 million homes suitable for new or top-up loft insulation and 1.2m tonnes carbon saving per year, excluding comfort taking which is estimated to reduce the savings by 15% (DCLG 2006). Meanwhile, under the Government's Energy Efficiency Commitment (EEC), which requires electricity and gas suppliers to meet targets for promoting household energy efficiency, the subsidised loft insulation programme is only expected to save 0.07m tonnes carbon per year by 2010 about 6% of the potential (DEFRA, 2006)

Over 90% of UK homes have central heating, mainly from a gas-fired boiler and radiators equipped with one or more heating controls; thermostat(s), plus a timer/programmer and/or thermostatic radiator valves (TRVs). Under 2005 UK Building Regulations new or replacement boilers must be A-rated energy efficient condensing designs, which if installed in 17 million suitable homes would save about 7% of household carbon emissions. A recent estimate is that A-rated boilers installed in 17 million homes would save 3.0m tonnes carbon per year (DCLG 2006). As boilers become more efficient, good controls are increasingly important. If consumers used existing controls properly it is estimated that about 3% UK heating energy consumption could be saved (MTP, 2004), while installing improved controls could save about 0.5m tonnes carbon per year or 1% household total (DTI, 2005). A recent estimate is that improved heating controls in 2 million homes could save 0.2m tonnes carbon per year (DCLG 2006). For energy efficient lighting, such as compact fluorescent lamps (CFLs) and emerging technologies such as Light Emitting Diodes (LEDs), estimates are that widespread adoption of CFLs could immediately save 0.6m tonnes carbon per year, about 1.5% of the UK household total (DTI, 2005). However, the annual carbon savings by 2010 from CFLs installed under the first EEC programme are only expected to be 0.06m tonnes, a tenth of the potential (DEFRA, 2006).

There is already a considerable body of work on the drivers and barriers to consumer adoption of energy efficiency measures. For example, a survey for the UK's network of Energy Efficiency Advice Centres (EEACs) showed that the main reasons given by a random sample of 200 UK householders for installing energy efficiency measures, was saving money or to increase comfort, while the main barrier to installing additional measures was cost (Central Office of Information 2001). A survey by npower (2007) of 1,192 UK residents showed the main driver for adopting energy efficiency was saving money (77%), environmental concerns (67%) and preserving the world for future generations (46%). A 1000 household interview survey and analysis for the UK Department of the Environment Food & Rural Affairs (DEFRA) showed that perceived cost far outweighs expected energy savings in consumer decisions to install energy efficiency measures, especially insulation (Oxera 2006). DEFRA's Energy Efficiency Action Plan stated, *'In the household sector, there are different barriers to improving energy efficiency, and three predominate: lack of information, high upfront costs, and hassle and disruption....' (DEFRA 2004).*

Existing research on household energy efficiency, at least that conducted by and for UK government, has thus tended to focus on the financial and informational drivers and barriers to household energy saving. However, there is another body of research (e.g. Guy and Shove 2000) which suggests that people's motivations and actions on energy are more complex than suggested by a rational model of decision-making mainly based on information and economics. For example, consumer diffusion of compact fluorescent lamps has been slow despite their clear financial benefits. Also different groups of consumers have different motivations, household needs and individual wants and so respond in different ways to energy efficiency. The National Consumer Council responding to the UK Government's 2006 energy policy consultation said,

'a better understanding is needed of the key motivations and influences of different groups of consumers.... In this way, energy efficiency messages can be targeted and made more effective' (NCC 2006).

Our research therefore attempted to examine consumer decisions to adopt, or reject, energy efficiency measures in more detail. We considered that the reasons for adopting or rejecting LZC technologies whose function is improving energy efficiency, such as loft insulation, may differ from those also involving user interaction, such as heating controls, or are part of interior design, such as lighting (Stokes et al 2006). The research also examined how consumers who adopted them used these products. This is important because even if people adopt energy efficiency measures, they may not use them in an energy-saving manner. For example, many people fail to understand, or could not be bothered, with controls such as thermostatic radiator valves or central heating programmers. There may also be rebound effects, such as taking some or all of the benefits of insulation in higher room temperatures; leaving energy efficient heating and lighting on for longer, or installing extra lighting in the home or garden (Herring 2005).

2 Methodology

The project comprised an exploratory study followed by main phase consumer interviews and surveys that aimed to identify:

- Key factors influencing consumer adoption, and non-adoption, of important household energy efficiency measures;
- The problems and benefits which adopters of these measures experience during installation and use; and whether they use the products in a way that reduces carbon emissions, including rebound or take-back effects;
- Specifications, ideas and concepts for improvements to, or innovations in, the products that would make them more desirable to consumers and effective in reducing carbon emissions;
- Policies and actions by designers, manufacturers, service providers and government that would promote the more widespread adoption of these energy efficiency measures.

2.1 The exploratory study

The exploratory study involved a literature review, pilot interviews with volunteer consumers, and an online survey of energy professionals to develop the methodology for the main phase.

In the exploratory study a model of consumer adoption and use of LZC products and systems was developed (Figure 1). It identified four groups of variables that influence consumers' adoption decisions and use behaviours:

- The socio-economic context (e.g. fuel prices, regulation)
- Communication sources (e.g. professional, interpersonal)
- Consumer variables (e.g. attitudes, lifestyle)
- The properties of the product or system itself – its functional utility, interconnectedness with other systems, symbolic value, and price.

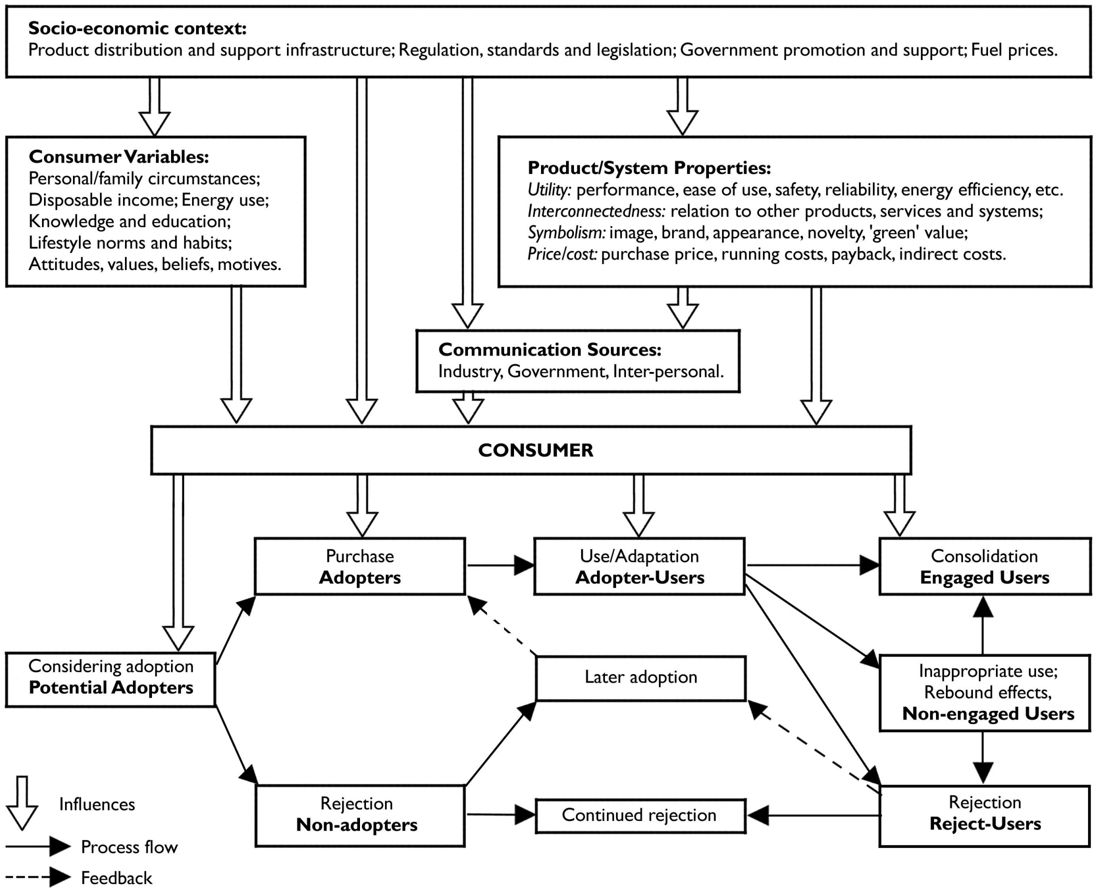


Fig.1. Model of adoption and use of LZC products and systems (Roy, Caird and Potter, 2007)

In the 14 exploratory interviews different consumer categories were identified and incorporated into the model. These included:

- *Potential adopters* (i.e. those considering adoption),
- *Adopter-users* (those who installed and used a LZC product or system),
- *Non-adopters* (those who seriously considered but decided against adoption i.e. rejectors)
- *Reject-users* (those who rejected a product or system *after* using it).

The adopters were further categorised into *engaged users* (those who adapted their behaviour to use the LZC product or system effectively e.g. to avoid rebound effects) and *non-engaged users* (those who did not use the product or system effectively).

For the main phase we focused principally on adopter-users and non-adopters.

The exploratory interviews and survey showed that the influences on the adoption and use of different LZC technologies varied, but all could be classified within our research model, giving confidence in its validity (see Roy, Caird and Potter, 2007).

The exploratory study also obtained the views of 50 energy professionals, such as local authority housing officers, architects and energy consultants, via a questionnaire linked to the *e-info@NHER* online energy newsletter, on the drivers and barriers to consumer adoption of energy efficiency measures and their ideas for improving the products to facilitate their more widespread adoption. The majority said they had good knowledge and experience of loft insulation, heating controls, condensing boilers and CFLs. However, less than half had good knowledge and experience of LED lighting and micro-CHP systems.

2.2 The main phase surveys

For the main phase we surveyed the factors influencing consumer adoption – and non-adoption – of loft insulation, heating controls, a condensing boiler, and/or compact fluorescent lamps (CFLs). Other than cavity wall insulation and domestic appliances, these are the main measures covered by the EEC (DEFRA, 2006). In addition, we gathered some information on adoption of two new technologies, LED lighting and micro-CHP systems. We also surveyed adopters' experience of installation and use of these products and gathered their ideas for improving them. The research was conducted in two ways:

via structured telephone interviews, each lasting 30 to 60 minutes, with 83 people who had sought advice from one of the two Energy Efficiency Advisory Centres (EEACs) operated by Milton Keynes Energy Agency (MKEA). We randomly selected EEAC clients from those who had sought advice about home insulation or central heating boilers between 2004 and 2006 (excluding those receiving state benefits) and interviewed those willing to participate and offered the option of a £10 incentive). The interviews then covered one or more energy efficiency measures from our list that the interviewee had adopted or rejected;

via an online questionnaire accessible to the general public posted in Spring/Summer 2006 on the website of the Energy Saving Trust (EST) and on a website linked to the BBC/Open University *Climate Chaos* TV series. This questionnaire produced 390 responses which included both adopters and non-adopters over the past four years of the above energy efficiency measures and/or household renewables (solar thermal water heating, solar PV, micro-wind turbines and wood-burning stoves).

Table 1 shows the energy efficiency measures researched via each sub-sample.

Table 1 Data sources on energy efficiency measures

Technology	Energy professionals	EEAC interviews of adopters and non-adopters	Online survey of adopters and non-adopters
Loft insulation	X	X	X
Heating controls: timer/programmers, thermostatic radiator valves	X	X	X
Condensing central heating boilers	X	X	X
Compact fluorescent lamps	X	X	X
Light emitting diode (LED) lighting	X		X
Micro combined heat and power (micro-CHP) system	X		X

Table 2 details the numbers adopting and deciding against adoption of the selected measures.

Table 2 Numbers adopting and rejecting energy efficiency measures

Energy efficiency measures	Installed (Online survey)	Seriously considered but decided against. (Online survey)	Adoption as % considering adoption (Online survey)	Installed (EEAC client interviews)	Seriously considered but decided against. (Interviews)
New or additional loft insulation of up to 270mm depth. (LI)	229 (59%)	59 (15%)	229/288=80%	28	7
Central heating timer/programmer.(HC/P)	286 (73%)	13 (3%)	286/299=96%	21(progmer or TRV)	0
Thermostatic radiator valves (TRV)	214 (55%)	53 (14%)	214/267=80%		0
Condensing central heating boiler (CB)	109 (28%)	97 (25%)	109/206=53%	7	0
Compact fluorescent lamp(s) (CFL)	275 (71%)	23 (6%)	275/298=92%	17	3
Light emitting diode (LED) lighting	28 (7%)	62 (16%)	28/90=31%	0	0
Micro Combined Heat and Power (micro-CHP)	3 (1%)	59 (15%)	3/59=5%	0	0
Total adoptions and non-adoptions	1144 (total number of respondents=390)	366 (total number of respondents=390)	1144/1507=76%	94 (total number of respondents=73)	10 (total number of respondents=10)

Note: some multiple adoptions

2.3 The respondents' characteristics

The respondents to the online questionnaire were self-selected and, as is detailed below, were 'greener' and from higher socio-economic groups than the general UK population. This is the result of these respondents reaching our questionnaire from websites concerned with energy efficiency and climate change. **More unexpectedly, the EEAC clients we interviewed claimed similar levels of 'greenness', and were also mainly middle class as is also detailed below**.

> **This is therefore a 'purposive' rather than a representative survey. Our respondents' reasons for non-adoption, and the problems of adopters, thus represent important barriers that need to be addressed before the less wealthy, less 'green' general population will consider adopting energy efficiency measures.**

2.3.1 The Energy Efficiency Advice Centre interviewees

The characteristics of the majority of interviewees who adopted one or more of our selected energy efficiency measures is shown in Table 3.

Table 3 Characteristics of the majority of interviewed energy efficiency adopters

Variable	Loft insulation N=28	Heating controls N=21	Condensing boiler N=7	CFL N=17
House size	22 (79%) live in 3 bed roomed and 4 bed roomed homes	17 (81%) live in 3 bed roomed and 4 bed roomed homes	5(71%) live in 3 or 4 bed roomed homes	14 (82%) live in 3 or 4 bed roomed homes
Type of house	14 (50%) live in detached homes & 8 (29%) live in semi-detached homes.	15 (71%) live in detached and semi-detached homes	5 (71 %) live in semi-detached homes.	7 (41%) live in detached &5 (29%)live in semi-detached homes
Main earner's occupation	10 (36%) retired; 8 (30%) professional/ senior mgmt; 3 (11%) office, clerical	7 (33%) retired	3 (43%) retired	4 (24%) retired
Level of concern about reducing impacts on the environment	10 (36%) Very concerned 10 (36%) Fairly concerned	11(52%) Very concerned 6 (29%) Fairly concerned	5 (71%) Fairly or very concerned	11 (65%) Fairly or very concerned

We interviewed too few energy efficiency non-adopters for reliable statistics on their characteristics (see Table 1). However, it may be worth noting that of the seven interviewed loft insulation non-adopters four live in terraced houses rather than the detached or semi-detached homes typical of the adopters.

2.3.2 The online survey respondents

The online survey produced 390 responses from people who had adopted – or seriously considered but rejected – one or more of the energy efficiency measures listed in Table 1 over the past four years. **However, its is important to note that this online group also included a number of people who had adopted, or considered but rejected, one or more household renewable energy systems (solar thermal water heating, solar PV, micro-wind or wood-burnings) and which are the subject of a separate report (Caird et al. 2007)**.

As is shown in the Results section below, a third of the energy efficiency sub-sample had adopted or considered one or more renewables, while about 40% of the renewables sub-sample had .recently adopted or considered energy efficiency measures. There is thus considerable overlap between the energy efficiency and renewables respondents.

Table 4 Characteristics of the majority of online survey respondents

Variable	Majority responses
Geographical location of home	347 (89%) live in UK 292 (75%) live in England
House size	162 (42%) live in 3-bedroomed homes 102 (26%) live in 4 bed roomed houses
Age of house	152 (39%) houses built before 1930, 89 (26%) houses built after 1965
Type of house	134 (34%) live in semi-detached, 131 (34%) live in detached 44 (12%) live in mid-terrace houses
Main heating system in home	312 (80%) have central heating boiler and radiators 106 (27%) have a condensing boiler 215 (55%) don't have a condensing boiler
Main heating fuel	278 (71%) use mains gas 39 (10%) use oil
Hot water provision	201 (52%) from central heating system, 105 (27%) from gas instant/combi boiler
Existing insulation	345 (89%) have some loft insulation 166 (43%) have 100- 270mm loft insulation 162 (42%) have cavity wall insulation 237 (61%) have double glazing on most windows
Size of household	253 (65%) live in 2 adult households 132 (34%) households include children under 16 years
Main earner's occupation	111 (29%) Professional/senior management 52 (13%) Retired 46 (12%) Education/medical services 22 (6%) Middle management 21 (5%) Crafts/ tradesperson 15 (4%) Office/clerical worker

N= 390 (Percentages are of the total sample which includes other responses and missing data)

Tables 5a and b (Appendix 1) present some more detailed characteristics of the online adopters and non-adopters of energy efficiency measures – divided into insulation/heating and lighting products.

2.3.3 Environmental attitudes and behaviour of respondents

Table 3 above showed that most *interviewed* adopters were 'green' consumers who said that they were fairly or very concerned to reduce their impacts on the environment; ranging from two-thirds for CFLs to about three-quarters for the other energy efficiency measures.

Table 6 Environmental concern of adopters of energy efficiency measures (online survey)

Environ-mental concern	Unconcer-ned	Quite unconcer-ned	Neither concern-ed nor unconcer ned	Fairly concern-ed	Very concern-ed	Total adopters	Missing data	% Fairly & very concern-ed
Loft Insltn	1	16 (7%)	3	50 (22%)	150 (66%)	229	9	88%
HC Progmr	1	23 (8%)	8	59 (21%)	182 (64%)	286	13	85%
TRV	1	17 (8%)	6	45 (21%)	135 (63%)	214	10	84%
C Boiler	0	10 (9%)	2	20 (18%)	70 (64%)	109	7	82%
CFL	1	14 (5%)	7	53 (19%)	188 (68%)	275	12	87%
LED	0	1	1	11 (39%)	12 (43%)	28	3	82%
Micro-CHP	0	0	0	1	0	3	2	

The results presented in Table 6 show even higher levels of 'greenness' amongst energy efficiency adopters who responded to the online survey, with over 80% saying they were fairly or very concerned to reduce their environmental impacts.

Perhaps surprisingly, Table 7 shows that non-adopters of energy efficiency who responded to the online survey had almost as strong green attitudes as the adopters, with 70% to 80% or more expressing environmental concern.

Table 7 Environmental concern of non-adopters of energy efficiency measures (online survey)

Environmental concern	Unconcerned	Quite unconcerned	Neither concerned unconcerned	Fairly concerned	Very concerned	Total Non-adopters	Missing data	% Fairly & very concerned
Loft Insltn	0	4 (7%)	3	5 (8%)	42 (71%)	59	5	79%
HC Progmr	0	2 (15%)	0	1 (8%)	8 (62%)	13	2	70%
TRV	0	5 (9%)	1	13 (25%)	30 (57%)	53	4	82%
C Boiler	0	7 (7%)	3	18 (19%)	64 (66%)	97	5	85%
CFL	0	1 (4%)	2	5 (22%)	13 (57%)	23	2	79%
LED	0	5 (8%)	3	7 (11%)	40 (65%)	62	7	76%
Micro-CHP	0	4 (7%)	0	8 (14%)	43 (73%)	59	4	87%

Table 8: Actions taken by respondents to reduce their impacts on the environment (online survey)

Actions to reduce environmental impacts	Total	Loft Insltn	HC Progmr	TRV	C Boiler	Micro-CHP	CFL	LED
Number	390							
Adopters (A)		229	286	214	109	3	275	28
Non-adopters (N)		59	13	53	97	59	23	62
Reduce, reuse, or recycle waste	354 (91%)	209 A (91%) 54 N (92%)	261 A (91%) 13 N 100%	197 A (92%) 47 N (87%)	98 A (90%) 90 N (83%)	0 A 56 N (95%)	253 A (92%) 21 N (91%)	24 A (86%) 55 N (89%)
Save energy	333 (85%)	198 A (86%) 47 N (80%)	250 A (87%) 8 N (62%)	185 A (86%) 42 N (79%)	90 A (83%) 81 N (84%)	0 A 50 N (85%)	243 A (88%) 16 N (70%)	21 A (75%) 49 N (79%)
Reduce transport impacts	214 (55%)	129 A (56%) 33 N (54%)	161 A (56%) 7 N (54%)	122 A (57%) 30 N (57%)	58 A (53%) 51 N (53%)	1 A 34 N (58%)	161 A (56%) 12 N (52%)	14 A (50%) 34 N (55%)
Save water	268 (69%)	161 A (70%) 40 N (68%)	204 A (71%) 10 N (77%)	144 A (67%) 41 N (77%)	78 A (72%) 74 N (76%)	0 A 48 N (81%)	194 A (77%) 14 N (61%)	18 A (64%) 47 N (76%)
Shop for environmentally friendly products	247 (63%)	141 A (62%) 36 N (61%)	179 A (63%) 7 N (58%)	132 (62%) 28 N (53%)	70 A (64%) 62 N (64%)	0 A 32 N (54%)	182 A (67%) 12 N (52%)	18 A (64%) 35 N (56%)
Reduce environmental impacts on home and garden.	272 (70%)	156 A (68%) 44 N (75%)	203 A (71%) 9 N (69%)	152 A (71%) 39 N (74%)	77 A (71%) 70 N (72%)	0 A 46 N (78%)	203 A (74%) 12 N (52%)	20 A (71%) 45 N (73%)
Community or political environmental action	71 (18%)	50 A (22%) 12 N (3%)	52 A (18%) 3 N (23%)	40 (19%) 9 N (17%)	21 A (19%) 20 N (21%)	0 A 15 N (25%)	55 A (20%) 2 N (9%)	4 A (14%) 10 N (16%)

Note: percentages given for adopter (A) and non-adopter (N) sub-samples

Table 8 shows that the majority of both adopters and non-adopters of energy efficient products and systems are taking environmental actions as follows:

- **Reduce, reuse, or recycle waste** – depending on the measure concerned 83% to 100% of adopters and non-adopters, i.e. almost all;
- **Save energy** – 75% to 87% of adopters and 62% to 85% of non-adopters;
- **Reduce transport impacts**, e.g. cycling, walking, using public transport – 50% to 57% of adopters and non-adopters;
- **Save water** – 61% to 81% of adopters and non-adopters;
- **Shop for environmentally friendly products** – 62% to 67% of adopters and 52% to 64% of non-adopters;
- **Reduce environmental impacts when looking after home and garden** – 68% to 74% of adopters and 52% to 75% of non-adopters;
- **Community or political environmental action** – less than 20% of the total sample.

There is no clear trend of adopters taking more environmental actions than non-adopters, except for CFLs where adopters have taken more environmental actions in every area than CFL non-adopters.

2.3.4 Summary of respondents' characteristics

Using SPSS to cross tabulate adoption data with characteristics of the sample reveals a strong profile reflecting the most typical characteristics of the energy efficiency adopters in the online survey.

- **Two–thirds are from two-person adult households** (61% to 67% depending on the measure), while **about a third** (32% to 39%) **come from households with children under 16 years**. The exception is LED lighting where the figures are 46% and 25% respectively;
- **A middle class household** where the main earner belongs to the occupational category of professional/senior or middle management (33% to 36%) or education/medical services (10% to 14%, or are retired (14% to 18%);
- **Living in semi-detached** (31% to 39%) **or detached houses** (29% to 35%) with three (40% to 45%) or four bedrooms (25% to 30%);

The characteristics of the interviewed adopters was similar, but with a higher proportion of retired people (36%).

The non-adopters' characteristics in the online survey, i.e. those who seriously considered adopting energy efficiency measures but decided against, **are similar to those of the adopters**, typically coming from:

- Two adult households (52% to 63% depending on the measure), with about a quarter (23% to 27%) not adopting energy efficiency measures from households with young families. LED lighting is again an exception with 77% non-adopters coming from 2 person households and 28% from households with children;
- Middle class occupations of professional/senior or middle management (27% to 33%) or education/medical services (11% to 15%) or retired (up to 11%);
- Living in semi-detached (31% to 47%) or detached houses (22% to 34%) with three (41% to 69%) or four bedrooms (13% to 28%).

We only interviewed 10 non-adopters; too few to make generalisations.

Most adopters, and non-adopters, of energy efficiency measures in the online survey are 'green' consumers. The great majority of respondents (82% to 88% adopters) depending on the measure (70% to 87%non-adopters), were fairly or very concerned about reducing environmental impacts. Almost all (83% to 100%) recycle household waste; most adopters (75% to 87%) and non-adopters (62% to 85%) attempt to save energy; while 57% to 79% try to cycle, walk or use public transport when possible. While this was not surprising for the self-selected online respondents, **the adopters we interviewed claimed similar levels of 'greenness'** (65% to 81% being very or fairly concerned about the environment) with most recycling waste, trying to economise on energy, water and car use.

3 Results

The results presented in this report are mainly based on an analysis of the 390 responses to the online consumer survey, with the results of the interviews of EEAC clients and the online survey of energy efficiency professionals providing supplementary information. The results are summarised in Tables 9-23 below.

The tables cover multiple adoptions, drivers and barriers to adoption, problems in use, and the benefits and impacts experienced by adopters. **The results also include ideas and policies for improving energy efficiency measures** agreed with, or independently cited by, more than 20% of the online consumer survey respondents, by the 50 energy efficiency professionals and in the 83 consumer interviews.

3.1 Multiple adoption of energy efficiency measures and renewable energy technologies

Analysis of the online-survey data for adopters and non-adopters given in Table 9 (using SPSS to cross tabulate adoption of LZC technologies) shows that **the majority of online respondents had adopted at least two energy efficiency measures** for the home. For example, half of the total sample adopted both loft insulation and central heating programmers, and at least half adopted three energy efficiency measures, including programmers, TRVs and CFLs.

Focusing on widely adopted heating controls or loft insulation, Table 9 shows that **very few online respondents have adopted both energy efficiency measures and renewable energy technologies**. For example, 11% of the total sample has heating controls or loft insulation and a wood-burning stove; 6% have LI or TRVs and solar water heating (STWH) and 3% have a programmer and solar PV.

Table 9 Multiple adoption of LZC technologies (energy efficiency measures and/or renewables – online survey)

Adopters LZC technologies	LI	HC/P	TRV	CB	CFL	LED	Micro-CHP	STWH	PV	MWT	WBS
Loft Insltn N=229 (59%)		194 (50%)	147 (38%)	75 (19%)	165 (42%)	25 (6%)	2 (1%)	23 (6%)	9 (2%)	5 (1%)	44 (11%)
Solar water heating (STWH) N =39 (10%)	23 (6%)	31 (8%)	23 (6%)	13 (3%)	29 (7%)	5 (1%)	2 (1%)		6 (2%)	3 (1%)	7 (2%)
HC Progmr N =286 (73%)	194 50%		196 50%	103 26%	207 53%	24 6%	3 1%	31 8%	11 3%	5 1%	43 11%
HC TRV N =214 (55%)	147 38%	196 50%		83 21%	156 40%	22 6%	2 1%	23 6%	8 2%	5 1%	43 11%

Percentages given for total sample = 390

Table 10 shows the results of a further analysis of the extent to which the adopters of energy efficiency measures consider but decide against adopting other energy efficiency measures and/or renewables. Using SPSS to cross tabulate data on adoption and non-adoption of LZC technologies, the results show that almost a third of the 390 online respondents who adopted an energy efficiency measure also considered but decided against adopting other LZC technologies.

The results show that a sizable proportion of adopters of energy efficiency measures have also seriously considered but decided against adopting renewable energy systems For example, about one fifth of the sample adopted loft insulation but following consideration decided against STWH (23%), solar PV (20%) and a micro-wind turbine (MWT, 21%), with similar results for heating control adopters. From another perspective more than 40% of the large sub-samples of heating controls and loft insulation adopters considered but decided against adopting STWH, and more than one third considered but decided against solar PV and/or a MWT.

What emerges from this analysis is that many of these adopters of energy efficiency measures say that they are seriously considering adopting renewables, even if they have decided against doing so for now.

Table 10 Adopters of LZC technologies who decided against adopting other LZC technologies (energy efficiency measures and/or renewables – online survey)

Rejectors of LZC technologies	LI	HC/P	TRV	CB	CFL	LED	Micro-CHP	STWH	PV	MWT	WBS
Adopters Loft insulation (LI) N =229 (59%)		5 (1%)	31 (8%)	58 (15%	11 (3%)	31 (8%)	32 (8%)	88 (23%)	79 (20%)	83 (21%)	42 (11%)
Adopters Solar water heating (STWH) N =39 (10%)	5 (1%)	2 (1%)	7 (2%)	12 (3%)	1 (0%)	6 (2%)	3 (1%)		12 (2%)	13 (3%)	6 (2%)
Adopters HC Progmr N=286 (73%)	47 12%		43 11%	76 19%	19 5%	54 14%	52 13%	118 30%	107 27%	105 27%	56 14%
Adopters TRV N=214 (55%)	33 8%	43 11%		52 13%	13 3%	37 9%	31 8%	90 23%	73 19%	72 18%	36 9%

Percentages given for total sample = 390

3.2 Drivers for adoption of all energy efficiency measures

3.2.1 Primary drivers

Table 11 shows that the online respondents installed loft insulation, heating controls, condensing boilers and energy efficient lighting, for the following most frequently cited reasons:

- **Saving energy and/or reducing fuel consumption**. This reason was given by more than three-quarters of the adopters of CFLs, loft insulation and heating controls, and over half of condensing boiler and LED adopters;
- **Saving money and/or reducing fuel bills**. This reason was given by more than three-quarters of the adopters of CFL, loft insulation and heating controls and over half of condensing boiler adopters.
  Many interviewed LI adopters (71%) voiced strong concerns about rising fuel prices;
- **Concern for the environment**. This was the second most frequently cited reason given by CFL adopters (82%) and third most common reason for adopting heating controls (57% programmers and 45% TRVs) or a condensing boiler (60%). Nearly 70% of loft insulation adopters, and the few micro-CHP adopters, also responded that they installed the insulation to reduce environmental impacts.

For loft insulation adopters the above three drivers were matched by the wish to have a warmer home. This was the third most frequently cited driver for adopting loft insulation (77%).

Some heating control adopters seemed to be referring to controls they already possessed; our research indicates that many consumers keep old controls when upgrading their heating system.

3.2.2 Additional drivers

These additional drivers are open-ended comments made by a few online respondents or interviewees and thus only provide anecdotal evidence (Table 11). For example, five online respondents mentioned that loft insulation helped keep their home cooler in summer, a benefit likely to become increasingly important with climate change, but not generally mentioned in subsidised insulation programmes.

Some CFL adopters pointed out the time/labour saving advantages of long-life CFLs because there is less need to spend time purchasing, installing and replacing the lamps. Adopters liked CFLs' long life but several expressed annoyance if a lamp failed after 1 to 3 years rather than the advertised 8 to 10 years. The life of CFLs thus acted as a driver but for some also as a barrier if they failed early.

Table 11 Drivers for consumer adoption of energy efficiency measures (online survey and consumer interviews)

Drivers for adoption	New or extra loft insulation up to 270mm	Heating Controls (progmer))	Heating Controls (TRVs)	Condensing boiler	CFLs	LED
Online survey	237	282	261	98	266	35
Interviews	28	21	21	7	17	0
Save energy/reduce fuel consumption.	200 (84%) **Rank 1** Cited in 12 (43%) interviews	220 (78%) **Rank 1** Cited in 6 (29%) interviews	154 (59%) **Rank 1** Cited in 6 (29%) interviews	75 (77%) **Rank 1**	242 (91%) **Rank 1**	20 (57%) **Rank 1**
Reduce fuel bills/save money. (interviewees reveal great concern about rising fuel prices)	192 (81%) **Rank 2** Most frequently cited in 20 (71%) interviews.	210 (74%) **Rank 2** Cited in 5 (24%) interviews	148 (57%) **Rank 2** Cited in 5 (24%) interviews	68 (69%) **Rank 2**	217 (82%) **Rank 3**	12 (34%) **Rank 2**
Increase comfort/be warmer/keep heat in.(important for sick & elderly)	182 (77%) **Rank 3**. Most frequently cited in 20 (71%) interviews.	104 (37%)	83 (32%)	34 (35%)	†	†
Concern for the environment/global warming/reduce emissions.	161 (68%). Cited in 6 (21%) interviews	162 (57%) **Rank 3**	117 (45%) **Rank 3**	59 (60%) **Rank 3 =**	218 (82%) **Rank 2**	4 (11%)
Because it was affordable or free/low cost/got a grant/special offer.	75 (32%) Cited in 6 (21%) interviews.	29 (10%)	19 (7%)	10 (10%)	†	4 (11%)
Adds value on property/would help sell it.	30 (13%)	23 (8%)	19 (7%)	13 (13%)	1	†
Improving/modernising home	55 (23%).	84 (30%)	61 (23%)	†	†	7 (20%) **Rank 3**
Doing building work anyway/part of other home improvements.	38 (16%)	51 (18%)	52 (20%) Cited in 6 (29%) interviews	21 (21%)	21 (8%)	†
Increase lighting levels (more or better lighting) in the home	†	†	†	†	45 (17%) Cited in 4 (24%) interviews	4 (11%)
For external lighting e.g. security lighting, garden lighting	†	†	†	†	31 (12%)	3 (9%)

Drivers for adoption (continued)	New or extra loft insulation up to 270mm	Heating Controls (progmer))	Heating Controls (TRVs)	Condensing boiler	CFLs	LED
Reliable, durable, zero maintenance product.	84 (35%)	†	†	†	†	†
Was a Do It Yourself job	72 (30%)	†	†	†	†	†
Had funds available to invest in improving heating system	†	†	†	31 (32%)	†	†
Required by 2005 Building Regulations	†	†	†	10 (10%)	†	†
Previous boiler/heating system needed replacement	†	†	†	59 (60%) **Rank 3 =** Cited in 6/7 (86%) interviews	†	†
Additional drivers *	Keep upstairs cooler in summer 5 (2%) Required by 2005 Building Regulations 5 (2%) Part of energy saving plan for home 2 (1%)	Address household need/heating problem. 14 (67%) interviews. Appropriate control of heating in the home 11 (4%)	Address household need/heating problem. 14 (67%) interviews. Appropriate control of heating in the home 13 (5%) Differential control of room temperatures		Less requirement to change lamps An example to visitors Less soiling of lampshades and ceiling	

† = not asked * Additional drivers were open-ended responses to the online survey and in the interviews

3.3 Barriers to adoption of heating energy efficiency measures

This section presents the barriers to adoption by these mainly green consumers of measures to improve the efficiency of a household's **heating** system (in section 3.6 below the barriers to adoption of energy efficient lighting is considered).

3.3.1 Primary barriers

Table 12 shows the barriers to adoption of energy efficiency measures from analysis of the responses to the online consumer survey. Also shown is some data from the interviews with EEAC clients and the survey of the energy efficiency professionals. The table shows that there are some common reasons why consumers seriously considered but rejected energy efficiency measures, although the main barriers are distinct and specific to the different efficiency measures.

Unsurprisingly, the majority of non-adopters of condensing boilers and micro-CHP considered these technologies too expensive. What is interesting is that a higher percentage of non-adopters of condensing boilers (70%) cited this as a barrier usually because there was no perceived need to replace a functioning boiler with a condensing boiler, compared with only 50% of non-adopters of the more expensive micro-CHP technology,. Financial issues, such as perception that likely fuel savings are not worth the cost was an issue for about a fifth of the non-adopters of these technologies.

Table 12 Barriers to adoption of heating energy efficiency measures (online survey and consumer interviews plus views of energy professionals)

Barriers to adoption	New or extra loft insulation up to 270mm	Heating Controls (programmers)	Heating Controls TRVs	Condensing boiler	Micro-CHP
Online non-adopters	59	23	30	87	62
Interviews with non-adopters	7	0	0	2	0
Energy efficiency professionals	50	50	50	50	50
Too much trouble to get installed	Trouble in clearing loft 18 (33%) non-adopters **Rank 2** 7 (14%) professionals	4 (17%) non-adopters. **Rank 2**	14 (47%) non-adopters. **Rank 1**	†	†
Expected disruption in the home.	12 (22%) **Rank 3**	†	†	8 (9%) non-adopters.	†
Likely fuel savings not worth the cost.	11 (20%) non-adopters 7 (14%) professionals	6 (26%) non-adopters. **Rank 1**	6 (20%) non-adopters. **Rank 2**	23 (26%) non-adopters.	9 (15%) non-adopters
Doesn't add to house value/saleability	3 (6%) non-adopters.	†	†	4 (5%) non-adopters.	3 (5%) non-adopters
Too expensive	†	†	†	Early replacement 61 (70%) non-adopters **Rank 1**	31 (50%) non-adopters **Rank 1**
Problems connecting to existing heating & electricity systems	†	†	†	21 (34%) non-adopters **Rank 3**	21 (34%) non-adopters **Rank 2 =**
Difficulty finding space/ suitable location for unit	†	†	†	Relocation of boiler. 8 (9%) non-adopters	17 (27%) non-adopters & 22 (44%) professionals
Reasons specific to each energy efficiency measure	Loss of storage space in the loft 20 (37%) non-adopters **Rank 1** Also 38 (76%) professionals Difficulty of access to water tanks, etc. 8 (15%) non-adopters. Loss of potential for a loft conversion 5 (9%) non-adopters.	Difficult to understand and operate 1 (3%) non-adopters. Also 34 (68%) professionals (41 (84%) professionals consider particularly for elderly/disabled)	Difficult to understand and operate 1 (4%) non-adopters. Also 34 (68%) professionals. (41 (84%) professionals consider particularly for elderly/disabled))	Reputation for unreliability 37 (43%) non-adopters **Rank 2** 20 (40%) professionals Negative attitude of installers 25 (29%) non-adopters 36 (72%) professionals Additional cost of CB 19 (22%) non-adopters 6 (12%) professionals.	A new technology with uncertain performance and reliability, as well as energy savings, economics 21 (34%) non-adopters **Rank 2 =** 24 (48%) professionals Insufficient electricity from system 10 (16%) non-adopters Noise 12 (19%) non-adopters 11 (22%) professionals

Barriers to adoption (continued)	New or extra loft insulation up to 270mm	Heating Controls (programmers)	Heating Controls TRVs	Condensing boiler	Micro-CHP
Additional barriers *	Health and Safety concerns with irritant fibres Critical timing missed during home improvements, including loft boarding Need for extra work/expense, such as new wiring, need to raise joists if boarding Timber may be endangered by condensation Difficulty insulating sloping walls and cavities	Unwillingness to replace functioning existing heating controls with modern ones. Preference to use a thermostat to control heating Concerns that timer is not compatible with heating system Complexity of digital displays compared with analogue design	Too much bother to change the settings as required TRVs stick and fail to operate properly	Replacement not necessary at present (11%) Advised that CB is not efficient for intended use Dislike features of CB, i.e. plume, condensate, new drain Lack of good advice to select boiler type, energy savings and installers	Difficulty finding trained installer/maintenance provider 23 (46%) of professionals Lack of availability

† = not asked. * Additional barriers were open-ended responses to the online survey and in the interviews

Moving on from the important financial deterrents, the most frequently cited deterrents cited by about a third who did not adopt loft insulation were loss of storage space and trouble clearing the loft; these are barriers to do with the interconnectedness of insulation with other building elements. The trouble of installation was also a key deterrent for adopting heating controls, particularly for nearly half of the non-adopters of TRVs. The reputation of condensing boilers for unreliability and having a shorter life was the second most frequently cited deterrent for about 40% of non-adopters, before such boilers became virtually mandatory in April 2005. Another important deterrents affecting about a third of non-adopters of condensing boilers prior to April 2005 were negative installer attitudes.
One potential adopter who decided against getting a condensing boiler said that installer actively put people off partly because they do not understand the boilers.

> *'Installers are very negative about them and say they have a much shorter life, corrode and get messy inside and leak vinegary stuff, and their shorter life negates fuel saving. Said there's no significant difference between a modern well maintained conventional boiler and a condenser, got the impression they don't enjoy servicing them. They were convincing because we did decide against a condenser.' (Condensing boiler non-adopter)*

About a third of non-adopters of condensing boilers and micro-CHP were also concerned about problems connecting to existing systems. Other deterrents for about a third of non-adopters of micro-CHP were problems finding space for the unit and uncertainty of the reliability and performance of this new technology.

Although 68% of energy efficiency professionals regarded heating controls difficult to understand and operate, this was only a barrier for 3-4% of the non-adopters of programmers or TRVs who responded to this survey (Table 12)

3.3.2 Additional barriers

These additional barriers are open-ended comments made by a few online respondents or interviewees and thus only provide anecdotal evidence (Table 12). For example seven online respondents expressed concerns with the health effects of the glass or lava fibre normally used for loft insulation. Some of these mentioned a preference for non-irritant, eco-friendly insulation materials, not normally included in subsidised insulation schemes. Early replacement was an issue with heating controls and condensing boilers with some of our respondents unwilling to replace functioning existing products.

Another important insight raised in interviews with non-adopters of loft insulation is that there is a critical timing for installing loft insulation, ideally before any boarding is laid and any delay may lead the homeowner to go ahead with the boarding with the result that insulation may never be laid. Clearly some home improvements and renovations need to be co-ordinated with home energy efficiency improvements. Indeed about a quarter of respondents did install energy efficient as part of other home improvements (Table 11).

3.4 Benefits of adopting heating energy efficiency measures

The majority of adopters of heating energy efficiency measures we interviewed or who responded to the online survey were very satisfied with the product they had installed, the main benefits being a warmer house, lower fuel consumption and a greater concern about saving energy coupled with some rebound effects (Table 14).

Table 14 Benefits and effects of adopting heating energy efficiency measures (online survey and consumer interviews)

	Loft insulation	Heating controls	Condensing boiler
Online Adopters	N= 237	N=282 programmers N=261 TRVs	N=98
Interviewed Adopters	N= 28	N=21	N=7
Positive appraisal	No problems experienced 71% interviewed adopters	Easy or fairly easy to use 71% online adopters timer/programmers 58% online adopters TRVs	Met expectations fairly/very well 68% online adopters
Negative appraisal	†	Difficult or very difficult to use <10% online adopters	Met expectations fairly/very poorly 3%
Benefits			
Warmer house	58% online adopters 82% interviewed adopters **Rank 1**	32% online adopters **Rank 2=** >50% interviewed adopters	36% online adopters **Rank 3=**
Lower fuel bills.	29% online adopters 36% interviewed adopters **Rank 3**	33 % online adopters **Rank 2=**	40% online adopters **Rank 2**
Greater energy efficiency, lower energy consumption.	31% online adopters **Rank 3** 29% interviewed adopters	40 % online adopters **Rank 1=**	45% online adopters **Rank 1**
Greater concern about saving energy	41% online adopters 46% interviewed adopters **Rank 2**	40% online adopters **Rank 1=**	37% online adopters **Rank 3=**
Reduced use of heating	6% online adopters	†	†
Less condensation/mould/damp	16% online adopters	13% online adopters	15% online adopters
Fewer health problems	4% online adopters	6% online adopters	3% online adopters
Rebound effects (admitted by users)			
No changes made	5% online adopters 21% interviewed adopters	A few	A few
One or more rooms are heated to a higher temperature	3 % online adopters 29% interviewed adopters	1 online adopter	4% online adopters
Heat more of the house	2 interviewed adopters	13% online adopters	5% online adopters
Heating is on for longer periods	1 interviewed adopter	9% online adopters 29% interviewed adopters using thermostat to control heating	4% online adopters
Less concerned about saving energy	†	6% online adopters	3% online adopters

† = not asked

3.4.1 Loft insulation

71% of the interviewees who installed loft insulation mentioned no problems with it. The majority of loft insulation adopters (58% online respondents) said the main benefit of loft insulation was a warmer house while fewer (31%) agreed they had lowered energy consumption, suggesting that some of the benefit was taken in warmth rather than saving energy. This is despite about 40% of them being more concerned about saving energy since they installed loft insulation. As one online adopter said,

> *'We reduced the temperature of the upstairs radiators and turned down the central heating thermostat by 2 degrees to 19 degrees C.'*

3.4.2 Heating controls

71% of timer/programmer and 58% of TRV adopters in the online survey found them easy to use with fewer than 10% reporting difficulties. About a third of heating control adopters reported lower fuels bills and/or energy consumption, while a third to a half of them said they benefited from a warmer house, suggesting some degree of rebound effect associated with heating controls. Indeed about 10% of heating control adopters admitted to heating more of the house and/or for longer periods following installation. Nevertheless, a greater proportion (40%) said they were more concerned about energy saving since getting new heating controls.

3.4.3 Condensing boilers

The benefits of installing a condensing boiler were similar to those of getting new heating controls, lower fuel bills or energy consumption (40% to 45%of respondents) and/or a warmer house (about a third of respondents) with greater concern about energy use (37%) and relatively minor rebound effects (about 5% admitting to using additional heating).

3.5 Problems for adopters of heating energy efficiency measures

This section reports on the problems experienced by adopters during installation and use of energy efficiency heating measures. Such problems can add useful insights to the key influences to their adoption.

3.5.1 Primary problems

The results in Table 13 are given for problems agreed with, or cited by, 10% or more of the online survey respondents who adopted energy efficient heating measures. The problems cited by consumers are compared with the views of the energy professionals on the problems they expected consumers to experience. The results show that less than 20% of adopters of loft insulation, heating controls and condensing boilers experienced significant problems during installation and use. However, the energy professionals expected many more problems, probably because they were more accustomed to dealing with less affluent, less environmentally aware consumers e.g. housing association tenants, the elderly.

The problems experienced by loft insulation adopters, namely trouble clearing the loft (19%) and loss of storage space (10%), mirror the main reasons given by non-adopters, suggesting that these are significant barriers to insulating lofts.

Very few of our respondents had difficulties understanding or using TRVs, despite some problems outlined below. However, around 10% of users of central heating programmers said they had difficulties understanding or using them, reading the controls and displays, or knowing how best to use their programmers to save most energy. For example, one adopter stated,

> *'They are more complicated to set up than the system we had in our old house and also are more restrictive and make it more difficult to save energy. Too many options mean it is easier just to leave the damn thing on'.*

This contrasts with the view of the energy professionals who said that over two-thirds of consumers have difficulties with central heating controls.

Condensing boilers, once the decision had been made to adopt (sometimes overcoming the negative attitude of installers, especially before mid 2005 when condensing boilers became virtually mandatory in the UK) were generally problem free, apart from technical difficulties experienced by a few users during installation.

Table 13 Problems experienced by adopters of heating energy efficiency measures (online survey compared to the views of energy professionals)

Loft Insulation	Heating controls Programmer	Heating controls TRV	Condensing boilers
Online survey	N=282	N=261	N=98
Energy professionals	N= 50	N= 50	N= 50
Trouble in clearing loft ready for installation 45 (19%) adopters **Rank 1**	Difficult to understand and operate 25 (9%) adopters **Rank 2** 34 (68%) professionals		Technical problems during installation/in use 16 (16%) adopters **Rank 1**
Loss of storage space in the loft. 23 (10%) adopters **Rank 2** 38 (76%) professionals If boarding is installed post-installation some remove insulation or compress it under boarding .	It is difficult to read the controls and displays 30 (11%) adopters **Rank 1** It is difficult to know how to use controls to save energy 25 (9%) adopters **Rank 2** 34 (68%) professionals		Negative attitude of installers 11 (11%) adopters **Rank 2** 36 (72%) professionals
< 10% adopters agreed or mentioned the following problems			
Extra-installation costs: re-wiring or building work to raise joists. Greater than expected disruption in the home Loss of potential for a loft conversion Difficulty of access to water tanks, etc. Loft may be less safe to use post-insulation for storage, or make it difficult to see covered joists when moving around.	Too much bother to change the settings as required. It is difficult to get access to their location.	Controls difficult to understand and operate Difficult to know how best to use controls to save energy Too much bother to change the settings as required Difficult to read the controls and displays Difficult to get access to their location	Greater than expected disruption in the home. Frequent breakdowns/ unreliability Also 20 (40%) professionals Users lack understanding of how CBs work Also 33 (66%) professionals
Additional problems **			
Health concerns about insulation materials, usually glass fibre because of links with asthma. Also experienced as irritating to skin and causing sneezing. House overheating following insulation in loft: means need to open windows or the loft to reduce temperature (in summer). Difficult to store items with temperature swings in loft from cold and damp in winter to very hot in summer leading to deterioration of stored items	Problems with changing settings Does not give user required control over heating	Problems with changing settings. Does not give user required control over heating. Poor operating efficiency due to sticking	Too large to fit existing space for boiler Conflicting advice on best system to install

** Additional problems are open-ended responses in the online survey.

3.5.2 Additional problems

There were several problems mentioned by individual adopters which can only count as anecdotal evidence. Several loft insulation adopters mentioned limitations on their ability to board the loft, or have safe access to fixtures such as water tanks if loft insulation covers the joists. Some mentioned requirements such the re-wiring or building work to raise joists for a relatively inexpensive technology. One adopter commented,

> *'I had to have new wiring in loft to allow it go round or lie over 270 mm thick insulation. To board the loft after insulation, the joists had to be raised and a new loft hatch made to allow boards into loft space. Insulation only cost £109 but other work increased cost to nearly £1,000.'*

A minority of respondents to the online survey find it difficult to use heating controls effectively. 9% said they find electromechanical timer/programmers with tabs fiddly to adjust, others, especially the elderly, find complex electronic programmers with LCD displays difficult to see and find the user interface counter-intuitive. Several interviewed users rely on relatives for assistance. The online survey results also show that 7% of heating control adopters have heating controls in inaccessible locations, such as under the slope of the stairs or in the loft. So settings are often not changed, and some users turn heating on and off using the thermostat because it is easier.

A few adopters also mentioned difficulties using TRVs effectively because they are fiddly with indicators that are difficult to see. Setting TRVs is difficult, having to be done individually through trial and error; they cannot be timed and tend to stick and be forgotten. For example, one adopter mentioned,

> *'It's easy to adjust them but I forget to turn down/off radiators when I'm not going to be in the room, and if I do turn them off, I forget to put them on again in time to warm the room up.'*

Adopters' beliefs also influence the way heating controls are used, sometimes reflecting a lack of clear advice on how to use heating controls. Some believe that it is more energy efficient to switch water and space heating on as required, whereas others (about 30% of interviewed users) leave heating on constantly and use thermostatic control and TRVs instead of the timer/programmer believing it's more energy efficient to leave heating on 24/7 all year. For example, one adopter said,

> *'You do not save energy by letting water or your home go cold and then cranking up the system again to required temperature.'*

Several said that they would like to know how best to control heating to minimise energy consumption and maintain comfort. More consumer guidance is needed on use of controls as well as to support the design of more automatic controls that achieve energy efficient comfort in the home.

3.6 Barriers to adoption of energy-efficient lighting

This section presents the barriers to adoption by these mainly green consumers of measures to improve the efficiency of a household's **lighting.**

3.6.1 Compact fluorescent lamps (CFLs)

About 70% of the online respondents had at least one CFL. These CFL adopters are also non-adopters because CFLs tend not to be used in all house locations.

The main barrier to adoption of CFLs mentioned by over 40% of our online respondents were their size and perceived ugliness when not hidden from view (Table 15). One interviewed non-adopter said,

> *'CFLs are too ugly for living room. You do not really want them to last as long as they do.'*

Another CFL non-adopter who preferred halogen spot lamps commented,

> *'I'm very fussy about my lighting'.*

This response seems to be based on views about older types of CFL as smaller designs in a variety of shapes are now available. The other barriers mentioned by a third of non-adopters are cost, incompatibility with existing light fittings and the quality of light CFLs produce. One interviewee said,

> *'CFLs are not worthwhile for rooms where you are always switching lights on and off because of extra cost. The life (of the CFL) is reduced when you switch it on and off.'*

Since lighting is used to create mood, atmosphere and décor, the colder colour temperature of CFLs may not be acceptable in rooms required for relaxation like the living room and bedrooms.

3.6.2 Light Emitting Diode (LED) lighting

Only about 7% of the online respondents had LED lighting. About 40% of non-adopters of LEDs mentioned their cost, lack of availability and their incompatibility with existing fittings. The other main deterrent mentioned was the inadequate brightness of existing LEDs making them only suited to decorative lighting. But many respondents said they did not know what LED lighting is and would want more and better information about it.

Table 15 Barriers to consumer adoption of energy-efficient lighting (online survey plus views of energy professionals)

Barriers to adoption	CFLs	LED
Online survey non-adopters	23	62
Online responses	24	57
Energy professionals	50	50
Often don't fit existing light fittings.	8 (33%) non-adopters. **Rank 2 =** 34 (68%) professionals	22 (39%) non-adopters **Rank 1 =**
Don't provide a bright enough light.	7 (29%) non-adopters. 30 (60%) professionals	17 (29%) non-adopters. **Rank 2** 8 (16%) professionals
Still too expensive to buy.	8 (33%) non-adopters. **Rank 2 =** 26 (52%) professionals	22 (40%) non-adopters. **Rank 1 =**
Likely fuel savings not worth the (Additionall) cost	3 (13%) non-adopters.	11 (19%) non-adopters.
Produce an unpleasant or unsuitable quality or colour of light	8 (33%) non-adopters. **Rank 2 =** 24 (48%) professionals	8 (14%) non-adopters. 8 (16%) professionals
Not widely available.	4 (17%) non-adopters.	23 (40%) non-adopters. **Rank 1 =**
Reasons specific to each lighting product	Ugly and/or too large when not hidden from view 10 (42%) non-adopters **Rank 1** 39 (78%) professionals Don't reach full brightness instantly 4 (17%) non-adopters 34 (68%) professionals Incompatible with dimmers 7 (29%) non-adopters 30 (60%) professionals Don't live up to their promise on product life and/or energy saving 2 (8%) non-adopters 15 (30%) professionals	Only suitable for decorative lighting 15 (26%) non-adopters **Rank 2** 8 (16%) professionals Consumers unaware of potential of LEDs for lighting 13 (21%) non-adopters 27 (54%) professionals

3.7 Problems for adopters of energy-efficient lighting

3.7.1 Compact fluorescent lamps (CFLs)

The barriers to the adoption of energy-efficient lighting were mirrored in the problems experienced by users (Table 16). The most common problem mentioned by about 40% of CFL users was their size and appearance, followed by their incompatibility with dimmers and slow warm-up time. The other main problems, each experienced by about a quarter of adopters, were cost, incompatibility with existing lamps and light fittings and inadequate brightness. These problems stopped some adopters from installing additional CFLs, especially since many didn't realise that CFL design and technology had improved considerably since they got their first lamp. Although users appreciated the long life of CFLs, a number were disappointed when they did not last as long as expected.

3.7.2 Light Emitting Diode (LED) lighting

The main problems experienced by the few LED users in our online survey were cost, and insufficient brightness, making them suitable only for decorative lighting.

Table 16 Problems experienced by users of energy efficient lighting (online survey and consumer interviews plus views of energy professionals)

Problems	CFLs	LEDs
Online adopters	N=266	N=35
Interviews	N=17	N =0
Professionals	N= 50	N= 50
Ugly/too large when not hidden	110 (41%) adopters **Rank 1** Also 39 (78%) professionals	†
Don't fit existing light fittings	77 (29%) adopters. e.g. Incompatibility with chandeliers, up-lighters, halogen spotlights and some table lamps and lampshades Also 34 (68%) professionals	†
Don't provide a bright enough light.	68 (26%) Adopters Some consider that that the equivalent incandescent light ratings are inaccurate Also 30 (60%) professionals.	7 (20%) **Rank 2**
Too expensive	63 (24%) adopters Also 26 (52%) professionals	8 (23%) **Rank 1**
Produce an unpleasant quality or colour of light.	43 (16%) adopters Mixed feelings about light quality, some like the whiter quality but others regard the light as too harsh and cold Also 24 (48%) professionals	3 (9%) adopters Also 8 (16%) professionals
Don't live up to their promise on product life	41 (15%) adopters Although several believe CFLs fulfil promised product life some thought performance and durability was variable. Also 15 (30%) professionals	†
Not widely available.	32 (12%) adopters Majority of lighting stock in shops is not energy efficient and the shopper has to hunt for CFLs.	†
Problems specific to each product	Not compatible with dimmers 94 (35%) adopters **Rank 2** Also 30 (60%) professionals Don't reach full brightness instantly 90 (34%) adopters **Rank 3** Also 24 (68%) professionals	Are only suitable for decorative lighting 6 (17%) adopters **Rank 3** Also 8 (16%) professionals Difficult to install 2 (6%) adopters

† = not asked

3.8 Benefits of adopting energy efficient lighting

3.8.1 Compact fluorescent lamps (CFLs)

Over 80% of CFL adopters said the lighting met their expectations well, providing benefits of lower fuel bills or energy consumption plus greater concern with saving energy (Table 17). However, some rebound effects were evident with about 10% admitting to leaving CFLs on longer than incandescent lamps, while 6% said they installed additional lighting in the home, garden or for security. One adopter stated,

> *'I now leave a light on in the hallway all day so that I don't have to come home to a dark house. I am also happy to leave the landing light on all night for my son. I would still prefer not to have the lights on for all the day, but feel better that the lights are energy efficient.'*

3.8.2 Light Emitting Diode (LED) lighting

Only about half of LED adopters said the lamps met their expectations well, presumably because of insufficient brightness for general lighting. One satisfied adopter stated LED lighting,

> *'Provides excellent background and decorative lighting for a very modern living dining room, ideal for watching TV. You can just about read with the LEDs'.*

Less than 10% of LED users noticed lower fuel bills indicating that the LEDs were probably used mainly to provide additional low energy lighting rather than to replace existing incandescent lamps or CFLs.

Table 17 Benefits and effects of adopting energy efficient lighting (online survey and consumer interviews)

	CFLs	LEDs
Online Adopters	N= 266	N= 35
Interviewed adopters	N= 17	N= 0
Met expectations fairly/very well	81% online adopters	51% online adopters
Met expectations fairly/very poorly	1% online adopters	9% online adopters
Benefits		
Lower fuel bills.	23% online adopters **Rank 3** Also some interviewed adopters	3% online adopters
Greater energy efficiency, lower energy consumption.	32% online adopters **Rank 2** Also some interviewed adopters	11% online adopters
Greater concern about saving energy since adoption	37% online adopters **Rank 1** Also some interviewed adopters	14% online adopters **Rank 1=**
Better lit house	9% online adopters	14% online adopters **Rank 1=**
Improved security	6% online adopters	14% online adopters **Rank 1=**
Rebound effects (admitted by users)		
Less concerned about saving energy	4% online adopters Also some interviewed adopters	None
Leave energy efficient lights on longer than before	11% online adopters Also some interviewed adopters	11% online adopters
Have more and/or brighter lights in the home	6% online adopters	11% online adopters
CFL lights not switched off as often as incandescent lamps (because of delay to reach full brightness).	9% online adopters	Not asked
Have installed additional lighting e.g. in garden, for security	6% online adopters	9% online adopters

3.9 Promoting more widespread adoption of energy efficiency measures

The drivers, barriers, problems and benefits of energy efficiency measures discussed above suggested several improvement ideas and design challenges.

Online respondents and interviewees were asked to respond to a list of possible improvements to the technology, design, installation, marketing, etc. of energy efficiency measures (generated by the research team following the exploratory survey of energy professionals) and also to suggest their own ideas.

This section summarises the responses mainly from the online sample, but with some of the additional ideas provided by the interviewees.

3.9.1 Improvement ideas for loft insulation

Loft insulation offers challenges for materials innovation. Three quarters (76%) of adopters said they felt that non-irritant, eco-friendly insulation materials would be a good idea, while 60% said they would like less bulky materials that provided the same insulation. Over half (54%) of the non-adopters said these improvements would have encouraged them to install (Table 18). Existing eco-friendly or high performance insulation materials are not available through UK subsidised insulation schemes. Lower cost alternatives such as encased rolls of mineral fibre insulation would also be worthwhile additions to subsidised schemes. This and several of the other desired technical improvements are already available, although this may not be known by the public.

The loft storage issue also needs a better solution than those currently available; a professional task of raising the joists and boarding or individual 'bodged' solutions. Nearly a third (31%) of non-adopters would have installed given a better method of providing post-insulation storage.

Table 18 Loft insulation – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas: new or extra loft insulation up to 270mm	Adopters	Non-adopters
Online survey	237	59
More user and environmentally friendly loft insulation materials.	76% **Rank 1**	57% **Rank 1**
Materials that provide the same insulation but are thinner/less bulky.	60% **Rank 2**	54% **Rank 2**
Systems to provide storage space above the insulation e.g. insulated boarding systems.	39% **Rank 3**	31% **Rank 3**
Loft clearance and storage service as part of the installation process.	24%	20%
Additional improvements*		
Eco-friendly, safer materials e.g. sheep's wool, recycled paper available via grant schemes and for DIY installations		
Insulating inaccessible, narrow locations e.g. sliding polystyrene or attaching an insulating blanket to the rafters		

* Additional improvements are open-ended ideas mentioned by online respondents

3.9.2 Improvement ideas for heating controls

Over 50% of adopters said the following were good ideas: controls that automatically optimise comfort and energy use; provide feedback on energy consumption, are designed for all users (including the elderly and disabled); display room-based set heating times and temperatures; and detect where heating is required in relation to room use. A third or more (33%-43%) of non-adopters said these improvements would encourage them to install new controls (Table 19).

Such responses suggest that there could be a demand for 'inclusively' designed, intelligent heating controls that provide feedback and operate automatically, but with manual over-ride. Other ideas are for controls with radio controlled clock settings that can be adjusted via a portable device or over the telephone or internet, or TRVs that can be calibrated for set temperatures, perhaps with child locks. There is also a potential demand for better information, maybe a computer program, to enable users to control their heating to optimise comfort and energy use taking into account the characteristics of their dwelling, heating system and needs. One adopter stated that he would like,

> *'Remote access to make changes by phone/internet. Simple ways of helping people to understand the links between their behaviours, meter readings and their bills – how they can save money by more than just switching providers.'*

Controls are often (and should be) part of package of energy efficiency improvements including loft and wall insulation, and boiler replacements. Users are interested in using combined measures effectively, that is energy-efficiency packages to save energy and keep warm.

Table 19 Heating controls – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas: heating controls	Adopters	Non-Adopters
Online survey	282	30
Systems that respond to room use and detect where heating is most required, adjusting the heating, without user intervention.	55% **Rank 1 =**	43% **Rank 1**
More ergonomic controls designed for all users (including elderly/disabled).	56% **Rank 1=**	33%
Controls that operate automatically to optimise comfort and save energy.	51% **Rank 2 =**	40% **Rank 2**
Controls that display set heating times and temperature for each room.	52% **Rank 2 =**	33%
Controls that provide feedback on money and energy used/saved.	53% **Rank 2=**	37% **Rank 3**
Controls located in a prominent place in the home e.g. kitchen.	41% **Rank 3 =**	†
Optional pc link-up for monitoring energy e.g. dedicated energy management system to control heating, lighting and electrics.	41% **Rank 3 =**	†
Additional improvements*		
Universal standards for controls, e.g. system to understand links between user behaviour, energy use and fuel bills.		
Remote control or portable heating controller for turning on heat in bedrooms, etc.		
Central heating programmers		
Control of heating for daily, weekly, weekend and holiday use.		
Automatic changes to clock settings e.g. Spring/Autumn when outside temperature is rapidly changing, BST/GMT changes or following a power cut.		
TRVs		
Temperature-calibrated TRVs, so that markings on TRVs correspond to room temperature, or give temperatures on TRVs or display record of settings to facilitate easy re-setting.		
Locking mechanism to prevent small children fiddling with them or making changes by mistake.		

† = not asked * Additional improvements are open-ended ideas mentioned by online respondents

3.9.3 Improvement ideas for condensing boilers

Table 20 shows that nearly half of non-adopters of condensing boilers would like more reliable and durable condensing boilers, and about a third would like easier to service boilers that displayed their working efficiency. About half of adopters would like to see working efficiency displayed, although some of the interviews revealed concern about improvements that create additional costs.

Table 20 Condensing boilers – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas: Condensing boilers	Adopters	Non-adopters
Online survey	98	87
A boiler that displayed its working efficiency.	52% **Rank 1**	32% **Rank 2**
More reliable and durable condensing boilers.	32% **Rank 3**	46% **Rank 1**
An easier to service condensing boiler.	34% **Rank 2**	30% **Rank 3**
Additional improvements*		
Design changes to make it easier to install boiler e.g. if condensate could be evaporated or if it did not need a condensate drain.		

* Additional improvements are open-ended ideas mentioned by online respondents

3.9.4 Improvement ideas for CFLs

The improvements that both non-adopters and adopters most wanted were CFLs compatible with existing fittings (especially halogen spotlights and dimmer switches, but also wall lamps, up-lighters, chandeliers, etc.) and with less harsh light quality (Table 21). About two-thirds of adopters would also like CFLs to be more energy efficient, more powerful and more widely available in shops. Another improvement idea is for CFL security lights designed to work with programmers and proximity switches or smoke alarms.

Manufacturers have introduced many of these improvements, but many consumers do not seem to be aware that they exist, partly because non-standard designs (e.g. dimmable CFLs) are not widely available and only stocked by specialist suppliers.

Table 21 CFLs – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas: CFLs	Adopters	Non-adopters
Online survey	266	24
Fit existing light fittings e.g. standard light bulb, spot lamp and candle bulb sizes.	72% **Rank 1**	45% **Rank 1 =**
Different colour rendering e.g. less harsh light quality.	42%	45% **Rank 1 =**
CFLs that can be dimmed.	55% **Rank 3**	42% **Rank 2**
CFLs with even higher energy efficiency.	64% **Rank 2**	29%
Wider range of lamp fittings for CFLs e.g. traditional lamps, decorative lamps, miniature lamps to fit cupboards, etc.	40%	33%s **Rank 3**
More powerful CFLs (e.g. 150 watt equivalent).	41%	25%
Wider availability, in shops, etc. e.g. with accurate labelling of the quality and spectrum of light emitted.	44%	29%
Additional improvements*:		
Energy saving CFL security lights designed to work with programmers, proximity switches and smoke alarms. Packs of CFLs to match 40/60/100/150 watt incandescent lamps.		

* Additional improvements are open-ended ideas mentioned by online respondents

3.9.5 Improvement ideas for LEDs

The main improvements for light emitting diode (LED) lamps desired by about half of both adopters and non-adopters were for improved suitability for general lighting and to match existing light fittings (Table 22). About half of adopters would like to see technical improvements to the quality and distribution of light that would improve suitability of LEDs for general lighting. About half of non-adopters would like more information available about LED lighting and its applications for energy saving.

Table 22 LEDs – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas	Adopters	Non-Adopters
Online survey	35	57
LEDs for all lighting functions and locations (not just decorative lighting).	57% **Rank 1**	46% **Rank 2**
Fit existing light fittings e.g. standard light bulb, spot lamp and candle bulb sizes.	46% **Rank 3 =**	51% **Rank 1 =**
New lamp and fitting designs to improve distribution of light.	51% **Rank 2**	†
Better information about uses of LEDs for lighting.	†	51% **Rank 1 =**
Improved light quality, i.e. better brightness and colour temperature.	46% **Rank 3 =**	28%
Information about energy and financial savings of LED lighting.	†	42% **Rank 3**

† = not asked

3.9.6 Improvement ideas for micro-CHP

Only three respondents had actually installed a micro-CHP system, one as part of a national Carbon Trust trial (Table 23). Two of these adopters would like to have had their system financed by an electricity supplier and paid back via fuel bills (also wanted by about a third of non-adopters).

Many people hadn’t heard of micro-CHP and two-thirds of non-adopters said that they needed more independent information about the technology, its performance and economics. An important issue for nearly half of non-adopters is being able to get a better price for electricity exported to National Grid.

Nearly half of non-adopters would also like smaller units with proven reliability and durability. About a third of non-adopters would be encouraged if there was improved support for installation and maintenance, proven environmental and economic benefits, and new designs that reduce noise and run on fuels other than mains gas.

Table 23 Micro-CHP – improvements considered good ideas/would encourage adoption (online survey)

Improvement ideas	Adopters	Non-adopters
Online survey	3	62
Better information about micro-CHP for domestic use.	†	41 (66%) **Rank 1**
Better price for electricity exported to National Grid.	†	31 (50%) **Rank 2**
Proven reliability and durability.	1	27 (44%) **Rank 3 =**
Smaller designs e.g. suitable to fit location of conventional central heating boiler.	1	27 (44%) **Rank 3 =**
Proven environmental and economic benefits.	0	23 (37%)
Reduced noise.	1	22 (35%)
System financed by energy supplier paid back via fuel bills.	2	18 (29%)
Micro-CHP designed to run on fuels other than mains gas.	1	19 (31%)
Improved support for installation and maintenance	1	24 (39%)

† = not asked

4 Conclusions

Our surveys show that each energy efficiency measure has different drivers, barriers, benefits and problems. Some of the findings support previous work, with its emphasis on financial drivers and barriers, but these surveys of mainly 'green' consumers also reveal a more complex picture.

The adopters of energy efficiency measures do so for many reasons; but in the online survey the main drivers were saving energy; reducing fuel bills and concern for the environment. This supports the findings of previous research. For loft insulation adopters these three drivers are matched by the desire for a warmer home and for condensing boilers the need to replace an existing boiler.

The barriers that deterred non-adopters of energy efficiency measures depended on the technology. For example, those who rejected loft insulation did so mainly because of losing loft storage space and/or having to clear the loft, the hassle factor identified in previous research. Most non-adopters of condensing boilers, at least before high efficiency condensing boilers became virtually mandatory, considered them too expensive, unreliable and/or short-lived. People decided against installing TRVs mainly because of the trouble involved, the hassle factor again. These barriers prevent many people from replacing conventional boilers and upgrading controls until absolutely necessary. The biggest deterrent to installing new or additional CFLs was their size and perceived ugliness (as found in other research), followed by their cost, incompatibility with existing fittings and/or dimmers and/or their light quality. Except for LED lighting as a new technology, lack of information did not feature very strongly as a barrier to adoption of energy efficiency measures in our survey of green consumers, although other studies cite information a major issue for the general population.

About a third of those who installed one or more energy efficiency measures said they noticed reduced fuel bills, despite rising energy prices. Some of this saving could be due to the greater energy awareness claimed by many users following installation. However, some 60% of loft insulation, a third of condensing boiler and heating controls adopters felt they took at least some of the energy savings in more warmth while 10% of CFL adopters felt they used or installed additional lighting. Energy efficiency technologies caused few operational problems apart from the difficulties some people had in operating central heating programmers and in using programmers and TRVs to optimise energy efficiency.

Promoting the widespread adoption and carbon-saving use of energy efficiency measures requires a multiple approach that needs to be tailored to the different products concerned. Policies and actions need to go beyond addressing the financial barriers to adoption, which were less important than other barriers for less costly measures such as insulation and lighting. Available subsidies, grants and special offers played a surprisingly small role in encouraging these householders to install energy efficiency measures. It seems that most wanted to improve the energy efficiency of their home before considering whether grants, subsidies or special offers helped to make adopting a particular measure affordable. Policies and action should include improving the design and technology of some existing products; improved communications about improvements to, and innovations in, established energy efficiency products; and guarantees regarding their performance, reliability and maintenance.

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Appendix 1 Detailed characteristics of the online survey respondents

Table 5a Detailed characteristics of the majority of adopters and non-adopters of home heating efficiency measures (online survey)

Variable	Total sample	Loft Insulation	HC Progmr	TRV	Condensing Boiler	Micro-CHP
N	390					
Adopters (A)		229	286	214	109	3
Non-adopters (N)		59	13	53	97	59
House size						
3-beds	162 (42%)	92 (40%) A 31 (53%) N	116 (41%) A 9 (69%) N	88 (41%) A 24 (45%) N	49 (45%) A 40 (41%) N	0 A 28 (47%) N
4 beds	102 (26%)	61 (27%) A 13 (22%) N	83 (29%) A 2 (15%)	65 (30%) A 12 (23%) N	28 (26%) A 27 (28%) N	0 A 14 (24%) N
Other house sizes (1,2,5,6 bedrooms)		64 (28%) A 11 (19%) N	71 (25%) A 1N	50 (23%) A 13 (25%) N	22 (20%) A 26 (27%) N	1 A 14 (24%) N
Missing data on house size		12 (5%) A 4 (7%) N	16 (6%) A 1 N	11 (5%) A 4 (8%) N	10 (9%) A 4 (4%) N	2 A 3 (5%) N
Type of house						
Semi-detached	134 (34%)	72 (31%) A 28 (47%) N	103(36%) A 6 (46%) N	71 (33%) A 23 (43%) N	42 (36%) A 34 (31%) N	1A 23 (39%) N
Detached homes	131 (34%)	80 (35%) A 14 (24%) N	96 (34%) A 4 (31%) N	77 (34%) A 18 (34%) N	34 (31%) A 34 (31%)N	17 (29%) N
Mid-terrace and bungalow		57 (25%) A 12 (20%) N	56 (20%) A 3 (23%) N	46 (22%) A 8 (15%) N	21 (19%) A 19 (20%) N	0 A 15 (25%) N
Other house types (flat, maisonette)		9 (4%) A 2 (3%) N	16 (6%) A 0 N	9 (4%) A 2 (4%) N	3 (3%) A 7 (7%) N	0 A 2 (3%) N
Missing data on house type		11 (5%) A 3 (5%) N	15 (5%) A 0 (0%) N	11 (5%) A 2 (4%) N	9 (8%) A 3 (3%) N	2 A 2 (3%) N
Size of household (adults & children)						
Size of household (1)		28 (12%) A 7 (12%) N	37 (13%) A 4 (31%) N	25 (12%) A 9 (17%) N	12 (11%) A 15 (15%) N	1 A 11 (19%) N
Size of household (2)	253 (65%)	155 (67%) A 36 (61%) N	189 (66%) A 7 (54%) N	141 (66%) A 32 (60%) N	67 (61%) A 61 (63%) N	0 A 36 (61%) N
Size of household (3)		23 (10%) A 6 (10%) N	29 (10%) A 0N	24 (11%) A 5 (9%) N	17 (16%) A 9 (9%) N	0 A 5 (8%) N
Other size households (4, 5,>5)		9 (4%) A 5 (8%) N	15 (5%) A 1 N	11 (5%) A 3 (6%) N	5 (5%) A 7 (7%) N	0 A 4 (7%) N
Missing data on household size		14 (6%) A 5 (8%) N	16 (6%) A 1 N	13 (6%) A 4 (8%) N	8 (7%) A 5 (5%) N	2 A 3 (5%) N
Household with 1 or more children (<16years)	132 (34%)	89 (39%) A 16 (27%) N	99 (35%) A 3 (23%) N	77 (36%) A 15 (28%) N	41 (38%) A 30 (31%) N	1 A 17 (29%) N
Main earner's occupation						
Crafts/ tradesperson	21 (5%)	*	13 (5%) A 3 (23%) N	14 (7%) A 1 N	2 (2%) A 8 (8%) N	0 A 2 (3%) N
Education/ medical services	46 (12%)	24 (10%) A 9 (15%) N	31 (11%) A 1 N	24 (11%) A 6 (11%) N	11 (10%) A 13 (13%) N	0 A 6 (10%) N
Middle management,	22 (6%)	12 (5%) A 5 (8%) N	16 (6%) A 0 N	11 (5%) A 4 (8%) N	9 (8%) A 5 (5%) N	0 A 2 (3%) N
Office/clerical worker	15 (4%)	9 (4%) A 4 (7%) N	12 (4%) A 1 N	9 (4%) A 3 (6%) N	3 (3%) 6 (6%) N	0 A 6 (10%) N
Professional/ senior management	111 (29%)	65 (28%) A 13 (22%) N	87 (30%) A 0 N	66 (31%) A 13 (25%) N	28 (26%) A 21 (22%) N	0 A 19 (32%) N
Retired	52 (13%)	36 (16%) A 6 (10%) N	43 (15%) A 2 N	31 (14%) A 6 (11%) N	19 (17%) A 11 (11%) N	0 A 7 (12%) N

Variable	Total sample	Loft Insulation	HC Progmr	TRV	Condensing Boiler	Micro-CHP
Other occupations (housewife/ husband, manual/factory worker, shop worker, student, unemployed, other)		32 (14%) A 22 (37%) N	21 (7%) A 3 (23%) N	11 (5%) A 7 (13%) N	9 (8%) A 9 (9%) N	1 A 5 (8%) N
Missing data on main earner's occupation		51 (22%) A 14 (24%) N	63 (22%) A 3 (23%) N	48 (22%) A 13 (25%) N	28 (26%) A 24 (25%) N	2 A 12(20%) N

A=adopter, N= non-adopter, * included in Other category
Note: results are for the *majority* of adopters and non-adopters where percentages are of the relevant sub-sample and multiple responses are possible.

Continued….

Table 5b Detailed characteristics of the majority of adopters and non-adopters of energy efficient lighting (online survey)

Variable	Total sample	CFL	LED
N	390		
Adopters		275	28
Non-adopters		23	62
House size			
3-beds	162 (42%)	114 (41%) A 11(48%) N	9 (32%) A 27 (44%) N
4 beds	102 (26%)	74 (27%) A 3 (13%) N	7 (25%) A 13 (21%) N
Other house sizes (1,2,5,6 bedrooms)		74 (27%) A 6 (26%) N	8(29%) A 16 (26%) N
Missing data on house size		13 (5%) A 3 (13%) N	4 (14%) A 6 (10%) N
Type of house			
semi-detached	134 (34%)	94 (34%) A 9 (39%) N	11 (39%) A 24 (39%) N
detached homes	131 (34%)	97 (35%) A 5 (22%) N	8 (29%) A 18 (29%) N
Mid-terrace and bungalow		54 (20%) A 6 (26%) N	4 (14%) A 13 (21%) N
Other house types (flat, maisonette)		18 (7%) A 1 N	1 A 2 N
Missing data on house type		12 (4%) A 2 N	4 (14%) A 5 (8%) N
Size of household (adults & children)			
Size of household (1)		34 (12%) A 7 (30%) N	5 (18%) A 6 (10%) N
Size of household (2)	253 (65%)	180 (65%) A 12 (52%) N	13 (46%) A 43 (77%) N
Size of household (3)		33 (12%) A 1N	4 (14%) A 4 (6%) N
Other size households (4, 5, >5)		12(4%) A 0N	2A 3N
Missing data on household size		16 (6%) A 3 (13%) N	4 (14%) A 6 (10%) N
Household with 1 or more children (<16years)	132 (34%)	87 (32%) A 6 (26%) N	7 (25%) A 24 (28%) N
Main earner's occupation			
Crafts/ tradesperson	21 (5%)	14 (5%) 0	1 A 4 (6%) N
Education/ medical services	46 (12%)	30(11%) A 2 N	4 (14%) A 8 (13%) N
Middle management,	22 (6%)	16 (6%) A 2 N	3 (11%) A 4 (6%) N
Office/clerical worker	15 (4%)	8 (3%) A 4 (17%) N	2 A 5 (8%) N
Professional/ senior management	111 (29%)	80 (29%) A 6 (26%) N	5 (18%) A 16 (26%) N
Retired	52 (13%)	42 (15%) A 0 N	5 (18%) A 4 (6%) N
Other occupations (housewife/ husband, manual/factory worker, shop worker, student, unemployed, other)		22 (8%) A 1N	2 A 4 (6%) N
Missing data on main earner's occupation		63 (23%) A 8 (34%) N	8 (29%) A 17 (27%) N

A=adopter, N= non-adopter
Notes: results are for the *majority* of adopters and non-adopters where percentages are of the relevant sub-sample and multiple responses are possible. Some data is missing